Growing Rare Plants

a practical handbook on propagating the threatened plants of southern Africa

by Geoff Nichols

Southern African Botanical Diversity Network Report No. 36 · 2005 ·

Seedling mix recipes

I have listed a series of seedling mixes below that will, with the addition of fertiliser, make good potting mixes for young plants.
Note that this information is intended as a guide only, as each area and climatic zone varies and each grower will have his or her own "favourite" medium.

Bulb mixes

Crocks must be placed in the bottom of each container for all bulbs.

Summer rainfall

- For species that are easy to propagate:
  2 parts river or industrial sand : 1 part compost
- For species that are difficult to propagate:
  3 parts river sand : 1 part compost
- For species that are really difficult to propagate:
  equal parts of washed river sand and industrial sand—leave the compost out altogether.

Winter rainfall

- For species that are easy to propagate:
  2 parts washed river sand or industrial sand : 1 part loam soil : 1 part fine compost
- For species that are difficult to propagate:
  1 part washed river sand : 1 part compost
- For species that are really difficult to propagate:
  3 parts sand : 1 part compost

Fleshy rooted bulbs

(such as *Clivia* and *Agapanthus*)

- Use a well-drained, humus-rich medium with some river sand to give a bit of bulk.
- 4 parts milled bark : 1 part of sand

Carnivorous plants

The best growing medium for *Drosera* and Terrestrial Bladderworts is:

- 2 parts peat : 1 part coarse river sand

Cycads

The most suitable medium for germinating cycad seed is one that is coarse and that will allow drainage yet be able to retain adequate moisture for germination. The sand should be washed and, as sand has a tendency to dry out, milled pine bark, peat, or compost must be added in.

- The ratio is 2 parts sand : 1 part milled pine bark, peat, or compost

Disas

- 1 part finely chopped palm fibre : 9 parts sand
- or New Zealand Sphagnum moss on its own
- or 1 part filtered fine grade silica sand (found in the south-western Cape) : 1 part medium grade silica sand placed in a 15 cm pot (as recommended by Wodrich)

Summer rainfall areas

Use river sand that is granite or sandstone based. Place a layer of New Zealand Sphagnum moss on the top of the pot to prevent algae from growing on the medium (Wodrich, 1997: 60–66).

Fynbos

Potting mix with soil

- 8 parts bark : 8 parts sand : 4 parts loam : 1 part fern fibre with 500 g ammonium sulphate fertiliser per cubic metre of mix

Potting mix without soil

- 2 parts bark milled : 1 part fern fibre, add 1,5 kg of low-phosphate 7:1:2 (27) per cubic metre of mix

Ericas, Proteas, and Buchu—cutting mix

- 1 part milled pine bark : 1 part polystyrene balls

Proteas—potting mix

- 2 parts sand : 1 part leaf mould or compost : 1 part loam

Ferns

Use soil rich in organic matter for spores.

- 1 part sphagnum or well-sieved leaf mould : 2 parts coarse sand

Pelargoniums

- 1 part loam : 2 parts sand : 2 parts compost

Plectranthus

- 1 sand : 1 loam : 2 parts compost

Restio seeds and plants in containers

- 2 parts milled pine bark or compost : 1 part loam : 2 parts industrial sand or coarse river sand

Stenoglottis

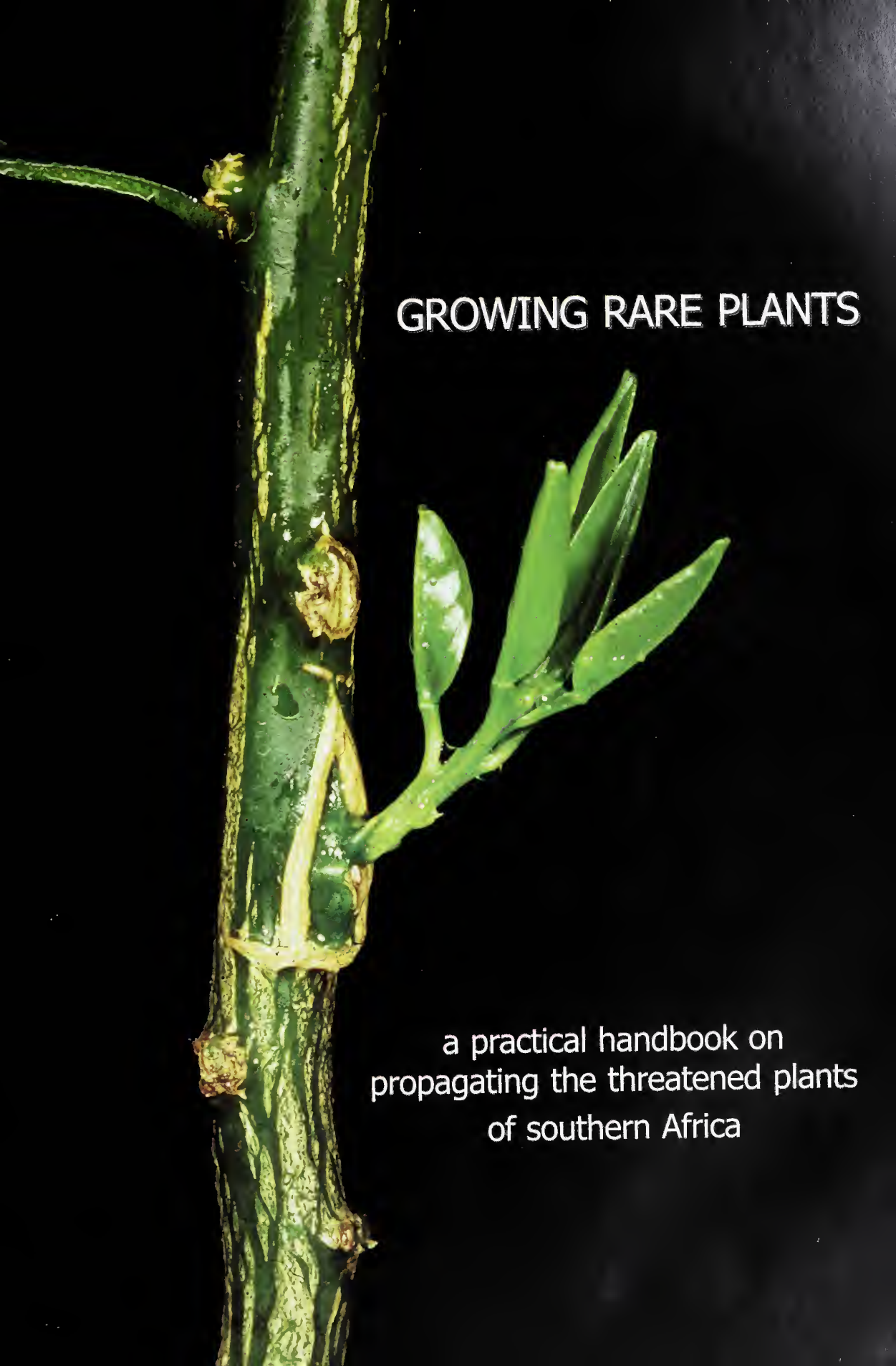
Remember that drainage properties are essential!

- 6 parts medium river sand : 2 parts compost : 1 part peat moss or fern fibre or palm fibre
- or 5 litres of shredded bark (usually our pine compost) : 2–3 cups of medium river sand

Some growers add polystyrene granules or rock wool to help bulk up and open the mixture for good aeration (Wodrich, 1997: 95–98).

Succulents

- 6 parts sand : 2 parts soil loam : 1 part leaf mould or compost in the soil mix. Add about 1 kg of lime to one cubic metre of soil mix.
- For succulent bulbs, use a 1 part commercial bark, usually consisting of pine bark (about 2–5 mm in size) : 1 part coarse river sand. A bit of soil can be added when the seedlings are ready to be transplanted.



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with contributions by
Mike Bingham, Neville Brown, John and Sandie Burrows, Gareth Chittenden, Neil Crouch, Graham Duncan, Trevor Edwards, Mark Gillmer, Anthony Hitchcock, Isabel Johnson, Alex Manana, Gavin MacDonald, Ian Oliver, Koos Roux, Guy Upfold, Ernst van Jaarsveld, Deon Viljoen, and Werner Voigt

Southern African Botanical Diversity Network Report No. 36 •2005•

Recommended citation format
NICHOLS, G. 2005. *Growing rare plants: a practical handbook on propagating the threatened plants of southern Africa.* Southern African Botanical Diversity Network Report No. 36. SABONET, Pretoria.

Citation of special features and quotations
JOHNSON, I. & TARR, B. 2005. *Gerbera aurantiaca:* The Hilton daisy. In G. Nichols, *Growing rare plants: a practical handbook on propagating the threatened plants of southern Africa.* Southern African Botanical Diversity Network Report No. 36. SABONET, Pretoria. pp. 78–79.

Produced and published by
Southern African Botanical Diversity Network (SABONET)
c/o South African National Biodiversity Institute, Private Bag X101, 0001, Pretoria

and

eThekwini Municipality
Parks, Leisure & Cemeteries Department
Parks, Recreation & Culture Unit
P O Box 3740
Durban 4000

Printed in 2005 in the Republic of South Africa by Capture Press, Pretoria, (27) 12 349-1802

ISBN 1-919976-17-5

Editor-in-chief: Marthina Mössmer
Subeditors: Lidia Gibson, Hanlie van Heerden and Alexis Symonds
Text design and layout: Suzanne Olivier, Antworks Layout and Design, Pretoria
Cover design: Suzanne Olivier, Antworks Layout and Design
Photo credits: All photographs © 2005 Geoff Nichols, except where noted otherwise in captions. Illustrations in glossary reproduced with permission from Beentje, 1994.

Front cover: A *Commiphora woodii* seed showing the red pseudaril, with unopened fruit in the background.
Back cover: *Haworthia viscosa* (top); *Gerbera aurantiaca* (middle); a selection of hard seeds (bottom; see page 28 for details).
Half-title page: A shooting bud.
Title page: Potting a *Pelargonium.*
Contents at a glance: *Gasteria glomerata* inflorescence.
Page facing contents page: *Haemanthus pauculifolius.*
Acknowledgements: (from left to right) *Lithops hookeri, Harpagophytum* tissue culture, *Welwitschia mirabilis* cones.
Preface pages: (from left to right) *Bombax rhodognaphalon* seed, *Conophytum smorenskaduense* flowers, *Helichrysum petiolarum.*
Introduction page: (from left to right) *Kalanchoe thyrsiflora , Disa uniflora, Conophytum smorenskaduense.*

SABONET website: www.sabonet.org.za

This report is a joint product of the Southern African Botanical Diversity Network (SABONET) and was made possible through support provided by the Global Environment Facility (GEF)/United Nations Development Programme (UNDP) and the United States Agency for International Development (USAID)/World Conservation Union-Regional Office for southern Africa (IUCN ROSA) (Plot no. 14818 Lebatlane Road, Gaborone West, Extension 6 Gaborone, Botswana), under the terms of Grant No. 690-0283-A-00-5950. The opinions expressed herein are those of the authors and do not necessarily reflect the views of USAID, the SABONET Steering Committee or SABONET National Working Groups.

SOUTH AFRICAN national biodiversity institute
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The World Conservation Union

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CONTENTS

Acknowledgements

Writing a book of this nature clearly involves many people. It is impossible for me to name everyone who has helped in one way or another, so if I leave a name out please forgive me. The names listed are not in any order of importance; all played an important part in making this publication possible.

Graham Duncan, Trevor Coleman, Anthony Hitchcock, Koos Roux, Ernst van Jaarsveld, Deon Viljoen, Werner Voigt, Ian Oliver, Trevor Edwards, Gavin MacDonald, Isabel Johnson, Doug McMurtry, and Mike Bingham helped in putting together detailed cultivation techniques for bulbs, ferns, succulents, fynbos, and orchids.

Mark Gillmer, Shane Pillay, Margaret Appleton, Hannes and Louise van Staden helped in cultivation and tissue culture techniques.

Brian Blades and Garth Kloppenborg of the eThekwini Parks Department allowed me access to their nurseries.

Lu Zonneveld, Elsa Pooley, and Neil Crouch helped with advice and images for some high-altitude plants. Jeremy Hollmann and Christo Botha lent images of the Aardvark and *Dichapetalum cymosum*, respectively.

Ian Garland, Mike Kruger, Hugh and Gareth Chittenden, Keith and Kersia Bailes, Doug and Nola Cooke, Bruce Blake, John and Sandie Burrows, Roddy Ward, Brian Strode, Jane Bertram, Martin Kunhardt, Mike Hickman, Teddy Govender, Richard Symmonds, Alex March, Jonathan Kromhout, Wally Menne, and Simon Woodley all work (or have worked) in nurseries and over the years have talked and shared ideas that have helped me gain a better understanding of what plants need to grow.

Len Jones, the Duke of Fynnlands, did the pen and ink drawings.

Ben Breedlove gave logistical and inspirational help.

Ona Davies and Llewelyn Foxcroft in the Kruger National Park helped with insights into plants and images of bushveld species I did not have access to.

Christopher Willis, Stefan Siebert, Nyasha Rukazhanga-Noko, Estelle Potgieter and Anne-Lise Fourie (the librarians at the Mary Gunn Library of the National Herbarium, South Africa), Yolande Steenkamp, Hugh and René Glen, Brian Tarr and Hans Heilgendorff (all of the South African National Botanical Diversity Institute), allowed me access to their various worlds to tap into their help and knowledge.

Alan Connell of the CSIR helped me with water flea information.

Riana Kleynhans supplied information on *Lachenalia* breeding.

Vincent Lourenco Jnr of Grovida helped with horticultural products.

Brendan Fox and Kenneth Robb provided images of *Bombax gnaphalocarpon*.

Richard Flint gave information on various pesticides.

Henk Beentje at Kew allowed me to use the pen and ink drawings from his book *Kenya Trees, Shrubs and Lianas*.

Lidia Gibson, Hanlie van Heerden, Alexis Symmonds, and Marthina Mössmer edited and organised the text.

Suzanne Olivier produced the beautiful layout.

To all these people my heartfelt thanks for allowing me into their lives for a while.

To my wife Lynne and our son Douglas thanks for putting up with my absences and eccentricities over all the years.

Preface

I understand the reluctance that grabs hold of you when you are faced with the daunting task of writing about something that has already been written about repeatedly. How do you present this as something new, worthwhile, of any relevance whatsoever? Plant propagation has been the subject of different publications, so why am I also joining the cause? I do believe that there is room for a book which is a personal account of different, highly knowledgeable individuals with first hand experience, willing to share it with other, interested propagators. This is really what this book is about—sharing knowledge gained through years of experience, in the hope that our threatened plants will ultimately have a chance at survival.

In my preparation, I trawled through literature for propagation and cultivation information, and came across articles that inspired me as a student and contributed in shaping my way of thinking. I have included these references, should you be interested to follow them up.

A large percentage of the literature I looked at relates to the northern hemisphere climates and tends to be far too detailed for the resources that are generally available in southern Africa. It is still important to read extensively, as an observation made often turns out to be a gem, putting you on track to the successful cultivation of a plant.

I consider *MacMillan's Tropical Planting and Gardening* (Barlow *et al.*, 1991), and Hartmann & Kester's *Plant Propagation Principles and Practices* my bibles. They contain a wealth of information that I have since childhood found extremely helpful. The first is a practical guide on methods of propagation and plant descriptions, while the second is a more detailed, academic approach to propagation. A third book that I find useful was printed in the early 1980s and is titled *People's Workbook* (Berold & Caine, 1981). It has since been revised and gives excellent, yet simple and practical, advice on growing crops. A fourth book that I could recommend is the *Guide to Handling of Tropical and Subtropical Forest Seed*, written by Lars Schmidt (2000).

A lot has been published on the taxonomy, ecology, and physiology of plants. Very little, however, has been written on growing southern African species. *Growing Rare Plants: a Practical Handbook on Propagating the Threatened Plants of Southern Africa* should be viewed as a stepping-stone to different ways of plant propagation. The aim is to introduce readers to ways and means, experimented with by other people, that would assist them in this task.

This book is offered as a point to start from for the next generation of propagators. The task ahead becomes more difficult to accomplish, because of habitat destruction in one form or another. At the same time, legislation concerning plant collecting has become stricter. In my experience, plants that belong to endangered taxa have decreased visibly. All these facts make the task more urgent, leaving less room for mistakes. Fortunately, we do have the advantage of technology, which enables us to store plants or their propagules for longer periods.

Research also has an important role to play—ten years ago, people knew about some of the effects of smoke on seed germination, and thanks to research, we now know a great deal more. We are able to use the information to speed up the germination process of many Fynbos plant species, and I would go as far as saying that the seed of grassland plant species would also benefit from this pre-germination treatment. With this knowledge, we could help ensure the survival of southern Africa's flora.



Introduction

There is no magic involved in growing plants! "Green fingers", or a so-called "feel" for growing plants successfully, is all about having a passion for plants. The process of plant propagation and cultivation is about experimenting with different methods to find the most effective way of growing a certain plant. It is about obtaining knowledge from experienced growers and, finally, it is about adapting newly gained knowledge to suit particular conditions and climates. The best propagators are people who have spent time in the field observing plants.

These people have a good understanding of plant types and families, and how plants are integrated in a specific habitat. Many threatened plants are simple to grow, given that the rules by which they live are understood and followed. It is important to do this kind of homework before plants are removed and exposed to unsuitable conditions. Very often, natural regeneration of these plants is hampered by a shrinking habitat and threshold of numbers. Some of these species are *Moraea loubseri*, *Gladiolus aureus*, *Haworthia limifolia*, *Siphonochilus aethiopicus*, *Warburgia salutaris*, *Ocotea bullata*, and *Prunus africana*.

The amount of attention given to certain families is interesting. The Orchid family is a good example. These plants are notoriously difficult to grow, emphasising the need for further research. While epiphytic orchids have proven relatively simple to maintain in cultivation, the same could not be said of terrestrial orchids. I have enlisted the help of local orchid growers and collectors to help demystify the group. In a complicated case like this, procuring your information from as many places and people as possible is very important. See yourself as a detective on a mission to find evidence that would shed some light on a case, in this instance, the propagation of a specific plant.

Where possible, I give detailed examples of species that have been grown successfully. The Wild Ginger (*Si-phonochilus aethiopicus*) is used as the main example in the Zingiberaceae family, carrying with it an interesting story, as well as valuable tips. To propagate this plant, we employed a set of methods, covering all eventualities, and came up with a successful conclusion.

Tissue culture and seedbank methodologies are mentioned, but not discussed in detail. Both are covered in other texts and require advanced technology. Should curators feel that it is possible to do tissue culture, institutions such as Kirstenbosch, the University of KwaZulu-Natal (Pietermaritzburg campus), or the eThekwini (Durban) Parks Department would be happy to assist.



Chapter 1

General information

▲ *A well-ordered succulent collection in the Karoo Desert Garden.*

THE AIM OF HAVING A GENERAL CHAPTER DEALING WITH common practices and issues is to avoid continuous repetition throughout the text and also to highlight important information right at the beginning.

Included in this chapter are:

- Labelling and keeping records of collections
- Containers
- Seedling and potting mixes
- Fungicides
- Mixing soil
- Filling trays
- Sowing
- Watering
- Temperature and light
- Transplanting seedlings
- Pests and diseases

Labelling and keeping records of collections

Labelling collections is of utmost importance for any serious collector. A plant label should impart a lot of information about the plant, including:

- Name of the plant
- Date of collection
- Accession number, which traces the locality where the plant was collected
- When it was pricked out and planted out
- Last name and initial of the person who collected or worked on the plant

In succulent collections, where plants remain in the same container for many years, the container itself can be labelled. The only criterion for the material used to make a label is that it should endure for years and still be legible.

From an accessioning point of view, it is very helpful when plants are physically laid out in the way that they are grouped in the computer or paper filing system. For example, plants are grouped according to family and genera and laid out in alphabetical order.

Plant propagation requires space. There should be enough space to avoid cramped and overgrown plants, which prove to be good only for the compost heap.

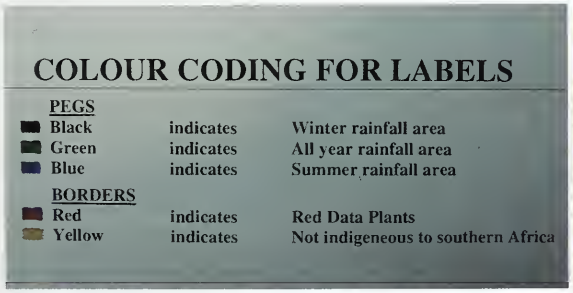
TIP

Use a soft 2B or B grade pencil on plastic labels. A pencil is best to use, because the graphite in a pencil is virtually indestructible and it does not fade or wear out with regular watering. Pencil writing can also be added to or erased.

COLOUR-CODED LABELS

Staff at the Karoo Botanical Garden in Worcester make use of colour-coded labels to communicate further information, for instance:

- A blue label indicates that it is a summer rainfall species.
- A black label indicates that it is a winter rainfall species.
- A green label refers to species that need all year round watering.
- A red border denotes that it is a red data species.■



▲ **left** *A legend for plant labels at Karoo Desert Garden;* **right** *A close-up of the labels showing colour-coding of species.*

Containers

Plastic multi-trays are the best containers for cuttings, because the medium does not become too waterlogged, as tends to happen in open, single trays. Roots also do not grow into the smooth plastic sides of multi-trays, as they tend to do in polystyrene trays. Furthermore, inhibiting chemicals on the polystyrene affects the cuttings, preventing new roots from developing at the nodes.

Once plants are rooted, they should be potted on. Generally, plastic sleeves or bags are used for the less delicate-rooted species. However, some nurseries may not be able to afford plastic sleeves or bags for their plants. Successful alternatives include old oil tins, plastic bottles, and cardboard fruit and beverage cartons. When I trained at the Durban Parks Department, before plastic became so easy to obtain, we used to collect all the old oil tins from the service stations around the Botanical Gardens and used these as containers for groundcovers and small perennials.

When potting on into bags, it is important not to drown the plants by overpotting into a huge bag. The roots should be allowed to fill the bag before being moved on into the next size up. If a plant is potted on into a too large bag, the soil might stagnate at the lower end, causing the soil to become sour. Roots that reach this point simply die off, setting the plant back.

Seedling and potting mixes

The soil mix is a medium in which to germinate the seed. It is a free-draining mixture that must be able to hold some moisture to start the germination process. Successful propagation depends greatly on the correct soil mix.

Mixing growing media

TIP

Always store and blend soil mixes on a clean, smooth concrete slab in a sheltered area—it keeps the mix dry, offers the opportunity to mix ingredients together without digging up other types of soil, and requires minimal effort to keep the working area neat and clean.

Every ingredient in these mixes must be sieved before mixing them together. There is nothing worse than trying to push a dibber or levelling tool into a large lump of sand or piece of bark.

1 Once all the ingredients are added to the pile for mixing, lightly dampen the mix to reduce dust and help bind the soil a little.
2 Mix all the ingredients together, with two people to pile the medium into the centre of a clear area. The method of turning the soil first from one side and then from the other side is called "double-turning". This method ensures that all the ingredients of the soil mix are well mixed to give an even texture to the potting medium. Using two people to do the mixing makes the work easier; one person can do it, but has to turn the whole pile twice.
3 Scatter the fertiliser evenly over the mixed pile and work the granules through the potting mix. Some seedling nurseries use an old concrete mixer to mix their soils—a method that works well if you do not use large volumes of soil.
4 Adjust the proportions of ingredients to the kind of quantities needed, implying that proportions can vary between one jam tin or spade to one scoop of a pay loader. Work out a unit mass for each unit used.

▲ *Mixing a growing mix using the double-turn method.*

Various soil mixes are listed on the inside front cover.■

▲ *Ingredients used in the preparation of growing media.*

Ingredients used in soil mixes include coconut palm fibre, coarse river sand, loam or topsoil, milled pine bark, fertiliser or manure.

Most commercial nurseries buy their potting media in from large commercial composting firms. These tend to be soil-less mixtures of mainly composted milled pine bark. Many ingredients are available as waste products from various packaging and manufacturing companies, for example, cocoa husks from the chocolate people, and rice and sunflower husks from the millers.

For special plants and sensitive collections, hand mixing certain ingredients is still the order of the day. Commercially available composts cater for the general market, and are inappropriate for the more specific needs of some of our threatened plants. Most growers advise collecting some soil from the plant's natural habitat. This can be analysed for its chemical or nutrient content to indicate what the plant needs to grow. Furthermore, the wild soil inoculates the nursery growing media with soil organisms, such as fungi, which may be useful to the plant you are trying to cultivate.

WARNING

It is of utmost importance that all seedling and potting mixes have good drainage. If this aspect is ignored, the propagating process is certainly doomed to failure.

The best mixtures are those that use sharp, coarse, 2–4 mm grain size river sand. Industrial sand, as it is called in some parts of southern Africa, is mined for making glass and can be used in the mixture. It is important to avoid materials that will break down too quickly into a clayey mess that holds too much water—shale and clay-based soils are best left out of seedling mixes.

Organic matter and its supply vary from place to place. Use what you are able to source from your area. Ensure that it does not change the pH of the mix and that it is well broken down before it is used in the seedling medium.

A local agricultural college or research station would probably be able to do a detailed soil analysis, making information available on the content, and shortage, if so, of chemicals and nutrients in the soil. There is no shortcut to test fertility of the soil, other than physically testing the soil about to be used.

Fungicides

Tree seeds, which sometimes take a long time to germinate, benefit from an application of a pre-emergent fungicide—this improves the chance of germination. The slow germination associated with some types of tree seed is particularly true in cooler, damp climates. The cost of these chemicals is high and should be taken into consideration.

At Kirstenbosch, the nursery staff use a long-acting fungicide as a pre-emergent drench, for example, Apron. This chemical contains a mixture of Captab and metalaxyl to prevent seed decay and seed-borne diseases, such as damping off, root rot, and downy mildew on young plants, which are caused by the *Phytophthora* and *Pythium* fungi.

Watering

Depending on the quality of your water, a good idea is to harvest and store rainwater in a rainwater tank. Rainwater is a true plant "pick-me-up", the best quality water for seedlings. Sensitive orchids fare much better on rainwater than municipal tap water. If the municipal water has a high chlorine content, fill a large tank and let the water sit in the tank for a day or more before using it. This

Filling trays

Before filling the trays, make sure that all old soil has been removed from the trays, as fungi and other insect pests hide in it and re-infest newly planted seeds. Wash the trays, containers, and tools for planting seedlings in Jeyes Fluid, at least a week before planting, and place them in the sun to dry. Sunlight is a great fungicide and it is free.

Once they are ready, fill the trays with seedling mix to a level about 20 mm from the top. This allows enough room during watering to keep water from spilling over the rim of the tray.

Once the medium is level within the tray, tamp it down using a tamping tool.■

1. Filling the tray with the soil mix.

2. Watering the soil mix. This can also be done in the larger pile of soil mix just before filling individual trays.

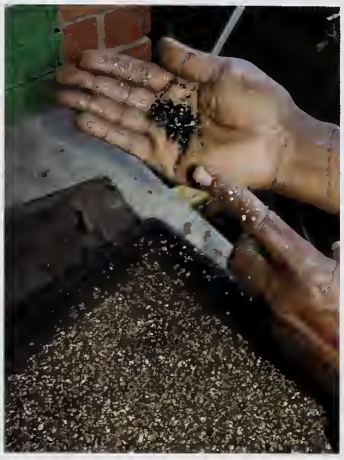
3. Tamping down the soil mix to provide a firm base on which to sow the seeds.

4. Levelling the soil in the tray. This ensures that seeds remain in one position and are not washed to one end of the tray.

Sowing

- Seed is the simple, natural way for plants to spread and reproduce themselves and cross-pollination increases the genetic diversity of plants.
- Water the tray thoroughly before sowing the seed. Once sown, the water will help to hold the seed in position in the tray. Sow the seed evenly and sparingly over the surface of the mix in the tray. Depending on the kind of seed, you may either have to cover it with a thin layer of mix or push it into the soil to ensure that it is held firmly in place.
- Tamp the seed down and water again, but lightly this time, using a watering can with a fine rose. If the seed is fine, stand the tray in a container of water about half as deep as the mix in the tray. The surface of the seedling mix will change colour as the water seeps up. Once the soil in the tray is saturated, remove the tray and place it in its position in the germination area.■

1. Remove enough seeds from the storage container to fit in the palm of your hand.



2. Place your hand over the tray and tap the underside of your palm to jiggle the seeds onto the sowing medium.

3. Cover the seeds lightly with some of the same sowing medium just to hold the seeds in place.

4. Write the name, date of sowing, and any other information for the seeds onto a label. I use pencil because it is legible for a long time and is not affected by water. It also means you can write a label with wet hands.

5. Place the label with the seedlings in their tray. Then water the seeds.

6. Water seedlings with a watering can using a fine rose, so you don't dig out the soil medium with large heavy droplets.

allows the chlorine to escape into the atmosphere.

Seedling soil should always be kept damp or moist, but not waterlogged. It is very important that the caretaker of the seedlings checks the plants at least twice a day and individually waters those trays that dry out faster. Automatic irrigation systems are not entirely reliable if there are many variables; the skilled human touch is by far the best method of monitoring.

Temperature and light

Morning sun and good ventilation are very important in the area used for germination

Raise the trays off the ground onto benches to allow air movement above and below the trays. Slugs and snails attracted to soft succulent vegetable matter and damp conditions, will not be able to reach the trays here. Keep in mind, however, that elevated trays tend to dry out faster' so monitor trays at least twice a day to ensure the soil medium does not dry out.

Allow seed to experience the normal day and night temperature fluctuations. If you live in a temperate region where the fluctuations of temperature are too severe in autumn or spring, place the seedlings in a cold frame. This structure is best placed against a warm, north-facing (for southern hemisphere growers) wall to receive maximum sunlight. At night, cover the seedlings with glass or clear plastic sheeting. If these materials are not available, insulate the frame with thatching grass, or any other type of roofing cover. Should day temperatures rise above 25°C, remove the covers in the early morning when the area starts warming up. The heat could scorch the plants if covers are left on the young plants.

Seedlings

Growing-on plants

If plants are to be planted out into the wild, they have to be toughened up to take the adverse conditions. By following these guidelines, I have seen a marked increase in the survival of young plants transplanted into the open ground and exposed extreme conditions of the sandy KwaZulu-Natal coastal soils.

▲ **left** *Elevated trays on wires in Durban Bridgevale Municipal Nursery. This ensures good air circulation, discourages pests like eelworm, earthworms, and ants, and diminishes rooting through into the soil;* **right** *Layout of seedlings in Bridgevale Nursery, Durban. Note the concrete substrate for clean, disease-free plants.*

▲ **left** *The nursery at the Lowveld Botanic Garden, Nelspruit. Note the concrete setting out area and high shade cloth. Concrete keeps weeds down and the extra height allows for growing larger trees in the nursery. Larger vehicles can also load and offload plants in the shade house;* **right** *Plant covering using shade cloth and plastic sheeting. This is done to ensure a more even temperature for small plants and less moisture is lost to evaporation.*

▲ Erica *cuttings showing drought stress.*

TIP

If you have to transport plants, ensure that the roots are kept damp at all times.

Sun

The first step is for the young plants to be hardened up so that they can take full sun. The shade-loving plants need to be placed in a shady area under trees or under shade cloth.

Wind

Wind is a killer of container-bound plants. The increased airflow increases transpiration and because water is limited in a container, plants can suffer quickly if not regularly watered. Plants should therefore be checked daily and watered when dry. Initially, it may be twice a day but later once daily. It is important to regard all these procedures as guides only, keeping in mind that each region will have its own special conditions.

Water

Another way of assisting plants in the wild is to add a water-storing gel (Terrasorb, Hygrosorb, Sanoplant, or Stockosorb) to the soil in the containers and in the hole into which the plant is placed. These gels are incorporated into the soil mix to provide an extra reservoir of moisture that becomes available to the plant's roots when rainfall is not adequate. The best gels are those that contain a synthetic polymer—polyacrylamide—that can absorb and release moisture over an extended period.

Fertiliser

A slow-release fertiliser in the initial potting mix at the time of planting out is perfect, because it gives a steady stream of nutrients for the young plant.

Another important key to successful propagation is plenty of organic matter in the final planting hole. For tree and shrub species, use digested sewage sludge from sewage treatment works. People have an aversion to using this material, but with rubber gloves and proper protective clothing, there should be no danger of human endoparasites, such as hookworm, infecting them. The sun and soil organisms will kill off any of these parasites. Plants respond wonderfully to the extra organic matter, high in nutrient value. However, if you live in a large city with a Health Department, you will most probably need various permits before you can use digested sludge.

WARNING

Do not overfertilise the plants, because they will get soft and grow too quickly. Fertiliser is a salt and makes the plants more attractive to browsers. It is like eating savoury snacks.

Frost and cold

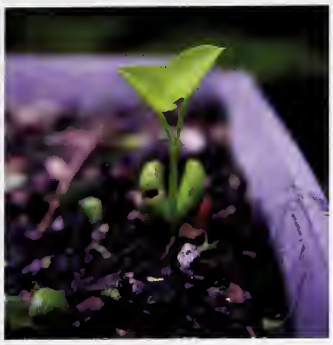
Many plants that are considered frost-hardy are hardy only as mature specimens. As young plants, they are still vulnerable and easily killed by frost.

There are no fixed rules—people grow what they like and enjoy, and gardeners are always ready for any new challenge. In general, however, it is the plants from harsh climates that have become the most enduring and popular garden plants.

Gardening is very disturbing to plants. Disturbances include the cultivation of soil, planting, transplanting, pruning and trimrning, adding compost and fertilisers, creating ponds, paths, and other structures, or breaking these down. Invasive pioneer plants, both native and introduced, have to be regularly weeded out, necessitating a regular disturbance of the soil. The very act of cultivating the soil benefits the emergence of pioneer plants—usually known as weeds. (New gardening techniques using mulches have helped somewhat.) Other disturbances come from the activities of domestic animals like dogs, cats, and poultry, as well as trampling from humans, especially children.

To survive in a garden or in cultivation, plants have to be "garden-fit". Many plants (for example, fynbos species like Ericas, Proteas, and Buchus) have a very sensitive root system that does not like any disturbance, as they originate in areas where they did not have to adapt to trampling or grazing. Some plants, however, grow easily in any garden, and are able to tolerate human handling, neglect, and ill treatment better than others. The secret of their success is their ability to tolerate disturbances, including grazing or trampling animals, droughts, frost, fire, or poor soil. This ability equips them to withstand the rigours of growing in a garden.

—Ernst van Jaarsveld.



▲ *A germinated* Erythrina lysistemon *seed, one week after sowing, shows its first leaves with swollen cotyledons below.*

▲ *Pricking out seedlings from growing trays. Note the elevated potting bench to facilitate work. Soil is added from behind the low wall. The soil is mixed behind this wall and the mixing area is usually higher than the level of the potting area to aid in moving the soil to a lower level so soil doesn't have to be lifted too high.*

▲ *Using a dibber to make a hole for the seedling in the soil mix.*

▲ *Filling a bag using a hollow tube trowel that holds more soil. Less movement of arms and hands makes for greater efficiency.*

Transplanting seedlings

A seedling's first leaves are the cotyledons. The next set of leaves are the real leaves. When there are two to four of these proper leaves, the seedlings are ready to be transplanted. Before taking the seedlings out of their trays, prepare the plastic pockets, tubes, or containers with potting soil. When filling the containers, tap the containers on the potting bench to shake out air pockets and firm up the soil. Once all the containers are filled, water well to saturate the soil completely.

With a dibber, make a hole in the soil of each container to receive the roots. Prick plants out of the trays into their individual containers. Water the tray well to soften and loosen the soil to prevent damage to the roots of the seedlings. Use a dibber to gently, but firmly lift the seedlings out individually. (If the whole tray is to be transplanted or pricked out, the soil and seedlings can be removed from the tray and laid out on the potting bench.) Working from one side, gently tease the roots of each seedling from the soil. Hold each young seedling gently by one or two of its leaves and carefully pull it away from the tray soil.

TIP

Hold the seedlings by the leaves and not the delicate stem. If a leaf is damaged, another will grow, but damage to the stem and its conducting tissue will stunt or even kill the plant.

Water the roots of the seedling so they take on a wet, streamlined shape. Ease the roots into the hole in the soil of the container. If the roots are too long for the tube, trim the extra roots with a pair of sharp scissors. Ensure the scissors are clean and sterile by soaking them in boiling water or commercial bleach, such as sodium hyperchlorite.
Tamp the soil back around the roots and finally fill the container, leaving about 20–30 mm of freeboard on the container for water to gather.

After having potted 10–20 plants, depending on how quickly you progress, water the new batch of plants. The water settles the plant in its new soil and pushes out any air pockets between the soil grains and the roots, enabling the plant to continue taking up water. Place the potted seedlings in a cool, sheltered place for about 7–10 days until they have "picked up" or recovered from the shock of transplanting. (After pricking them out, most plants tend to wilt, but pick up once their roots are settled.) It is possible that some plants are lost in the transplanting process. The cause of plant loss is often linked to dried out roots and rough handling. The word *gently* cannot be repeated often enough.■

Take note that the soil mix must be suited to the plant! See the list of soil mix types on the inside front cover for recipes.

▲ *Once the bag is filled, place the plant at the correct root level and secure it into the soil using your fingers.*

TIP

Provide protection for young saplings during the first two or three winters after they have been planted out.

A simple grass thatch cover or tent-like structure over the tree and a wrapping for the stem of the tree, consisting of thatching grass, will successfully prevent cold and frost from causing damage. Leave an opening that faces north to collect light and heat for the sapling.

Pests and diseases

Pests can become a problem when attempting to maintain collections in captivity, especially under glass or other waterproof structures. Inspect plants daily. Remove sick plants to a quarantine section and remove all dead flowers and leaves to prevent pathogen build-up. The key to controlling pests is to ensure that life is made as difficult for them as possible and this includes limiting their food supply. Daily maintenance of the plants is an essential preventative measure as it may save hours of trouble later.

Contact your local agricultural chemical supplier and find the registered chemical for the correct insect pest or pathogen.

Some growers use biological controls, but these are difficult to maintain in areas that are not completely closed in. They are available for certain greenhouse pests, but are expensive and need a relatively high level of skill to obtain proper control.

The Internet is a useful tool to research pests and diseases. When all else fails, ask one of the other SABONET curators or specialist growers for help.

Always read the latest literature and make use of the Internet for help to manage plant collections. Representatives of various agricultural products, including pesticides, will give you samples and assistance in order to sell their products. Do not forget that these are sales people and will want to punt their own products. Focus on finding the best product for your needs.

TIP

Remember that a combination of pest control methods is always the best. This is known as Integrated Pest Control (IPC).

The following pests are the main culprits in most collections:

- Aphids
- Fungi
- Lily borer (Amaryllis caterpillar)
- Mealy bug
- Red spider mite
- Scale
- Thrips
- Wildlife

Aphids

An aphid is a small soft-bodied insect of the homopteran family Aphididae, whose members live on plant juices and include many plant pests, for example, greenfly or blackfly, Common Rose Aphid, Oleander Aphid, and Cotton Aphid. All these insects are easily controlled in the open areas of a garden by predatory insects like Ladybird adults and their larvae.

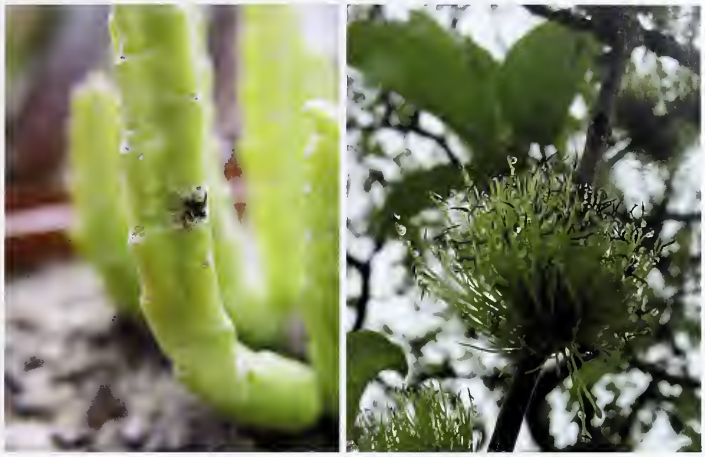
The most famous biological control insect is the Lunate Ladybird, *Cheilomenes lunata*. This species will always be found where aphids are a problem, making it imperative that you observe your plants before resorting to insecticides. Rather use the non-toxic methods of control.

▼ Aphis nerii, *the Oleander Aphid, on Milkweed*—Gomphocarpus physocarpus. *Milkweeds are good companion plants that attract aphids away from your target crop.*

▼ *A ladybird adult feeding on citrus aphids on* Zanthoxylum capense. *The ladybird is an introduced species from Europe.*

Hoverflies and even White-eyes also feed on aphids. These little birds are probably the best predators that you can have in a cultivation system. I would even go as far as leaving small holes in the glasshouse netting to allow these birds entry to the plants (Picker *et al.,* 2002; Van Jaarsveld, 1999).

If you have a totally enclosed system, a systemic insecticide is what needs to be used on these insects.



▲ **left** *Black rot fungus on* Stapelia. *Cut off the offending part and burn it,* **right** *Witches' broom in* Combretum zeyheri.

Fungi

Phytophthora *and* Pythium

Phytophthora and *Pythium* cause damping off, root rot, and downy mildew on young plants. Poor drainage coupled with untidy accumulation of soil and plant debris is the main cause for a fungal infestation (Bayer, 1980).

Many Proteaceae and Ericaceae are susceptible to a fungus know as *Phytophthora cinnamoni*. This fungus will kill a plant in a matter of weeks. The best protection is to plant in a well-drained soil, rich in organic matter. Keep the roots relatively cool by not exposing the soil to the hot sun, use mulch, and don't weed mechanically around the trees (Knox-Davies, 1975). This scarifying only damages surface feeding roots and allows the fungus another point to enter the plant. This problem is more prevalent in the winter rainfall region because of the dominance of these plant families in the Fynbos.

Plants and seedlings that are not adequately ventilated and do not get enough sunlight are more prone to these fungi.

Black rot

Like many fungi, the Black rot fungus attacks plants as a secondary infection. It is caused, in the case of succulents, by insect damage or sometimes by water sitting on the plant when it is too hot or cold, allowing the fungal spore to germinate and invade the plant. As in all fungal infestations, plant and growing house hygiene is important. Careful watering to prevent splashing onto the plant's surface helps to minimise the problem (Barlow *et al.*, 1991).

Witches' broom

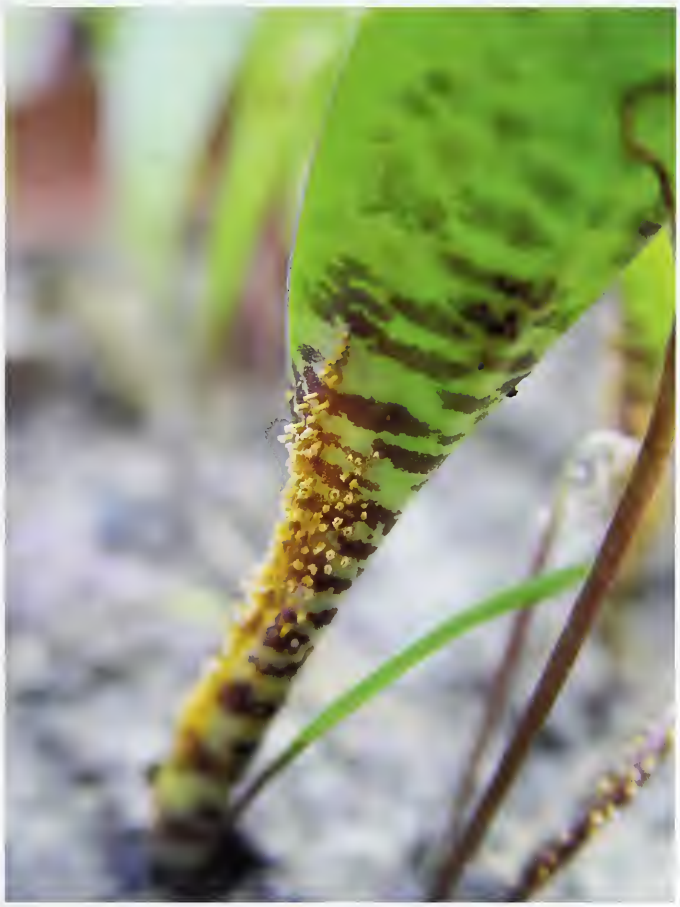
A fungal disease of plants characterised by an abnormal growth of broom-like, stunted twigs. This is usually caused by a virus introduced into the plant via a sucking insect like a twig wilter or aphid. The pathogen causes a proliferation of lateral buds to produce fan branching or close clustering of stems. The best control of this problem is to cut off and burn the affected branch or branches (Barlow *et al.*, 1991).

Prevention of fungal infestations

Use the following preventative measures:

- Wash off any gelatinous, jelly-like substance in clean, cold water by rubbing the seeds together gently after the soaking process has been completed. These waxy outer layers can hold chemical inhibitors, as well as

▼ *Fungus affecting a* Lachenalia *seedling.*



▲ *Amaryllis or Lily Borer caterpillar.*

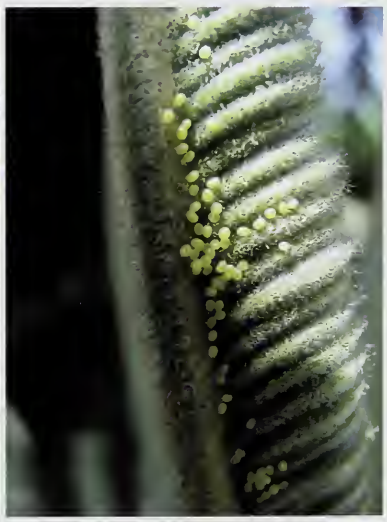
▲ *Amaryllis or Lily Borer eggs.*

▲ *Cherry Spot caterpillar.*

▲ *Cherry Spot caterpillar damage.*

▲ *Cycad Looper caterpillar.*

▲ *Cycad Looper moth.*



▲ *Cycad Looper eggs.*

harbour soil fungi, which feed on the organic compounds that could possibly cause the germinating seed to rot.

- Maintain even temperatures in your growing house. If it overheats, the atmosphere becomes too humid and fungi will infest the collection.
- Do not water in the heat of the day, as this will drop the soil temperature compared to the ambient temperature of the growing house. The cooling then allows fungi a window of opportunity to attack your plants.
- Leave plants as dry as possible at night so that fungi do not have an ideal damp microclimate in which to infest your plants.
- Strong light conditions are essential.
- Ensure enough space between seedlings to allow them to develop freely.
- Good ventilation and proper sanitation limit infestations.

REMEMBER

Orchids need certain fungi to ensure growth. Use the soil inoculation method.

▲ *Mealy bug on* Haworthia *plants get into the growing crown and between the roots.*

▲ **left** Brunsvigia *infested with mealy bug;* **right** *Mealy bug on leaves of* Crinum macowanii *in a growing house.*

Lily borers

The Lily Borer or Amaryllis caterpillar *(Brithys crini)* affects larger outdoor collections. A point to remember about the Amaryllidaceae is that they are all attacked to a greater or lesser extent by the introduced Amaryllis caterpillar.

This insignificant moth lays its eggs on the underside of leaves. Each egg is about the size of a pinhead. The moth will lay about 50 in one cluster. The larvae are striped yellow and black. When the larvae hatch, they begin tunnelling their way through the leaf. If the leaves run out before the caterpillars are ready to pupate, they continue their journey into the bulb. If you are unlucky, they can eat out the basal disc. Therefore, prevention in this case is definitely better than cure.

If you have only a few *Boophone, Cyrtanthus,* or *Crinum* plants, check them each day by running the leaves between your fingers. If you feel a cluster of eggs simply rub them off the leaf. This is known as the TLC (Tender Loving Care) method! However, if you have many plants of the amaryllis family then feeling each leaf is a little impractical. I suggest you use a contact insecticide that will only affect the caterpillar once it starts feeding.

The active ingredient in the insecticide I recommend is carbaryl. Read the label carefully before making your purchase. Use only the dosages recommended on the label. Spray only the underside of the leaves—the larvae start there and not anywhere else. You'll need to spray once every ten days or after heavy rain.

On the KwaZulu-Natal coast, these moths fly all year round.

A related Lily Borer known as Cherry Spot (*Diaphone eumela*) attacks members of the Agapanthaceae and Asphodelaceae. *Agapanthus, Scilla, Ornithogalum* and *Albuca* are all attacked by this species. Treatment or control is the same as above.

Mealy bug and Australian bug

Mealy bug, *Pseudococcus* species and *Planococcus* species, and Australian bug, *Icerya purchasi,* hide in deep cracks of bark and in tight leaf bases. They are very difficult to dislodge. Mealy bug tends to be more problematic in enclosed growing houses than out in the open. I believe in the dictum of Bayer: "Mealy bug, like many other ills, cannot bear attention. Losing plants to this pest is excusable only on the grounds of neglect" (Bayer, 1980).

Mealy bug infects collections through contaminated containers. To treat Mealy bug, drench the plants and containers with a solution of broad-spectrum insecticide like Malathion. Ensure that the chemical is spread evenly over the entire plant. In the case of asclepiads, a secondary fungal infection, known as Black Rot, can spread throughout a collection like wild fire (Picker *et al.,* 2002; Van Jaarsveld, 1999).

Red spider mite

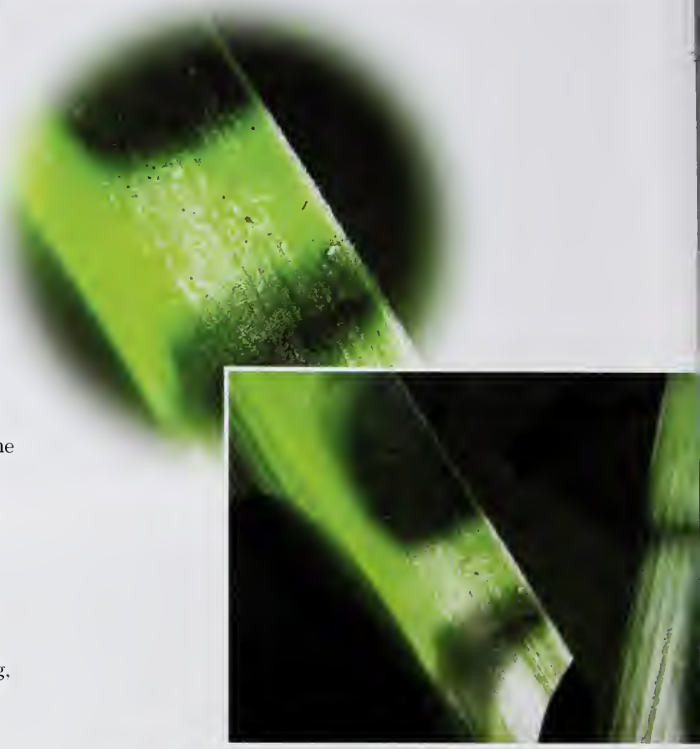
Red spider mite, also known as red spider, is a small red mite, *Tetranychus urticae*, and a serious horticultural pest. It is a common problem in succulent collections and is controlled by regular spraying programmes. Red spider mite attacks most plant families if the conditions in a growing house are too dry. To keep the plants at the right humidity is a hard call, especially in a succulent drying house.

Ernst van Jaarsveld at Kirstenbosch describes this sap-sucking pest as being barely visible to the naked eye. They can be detected by their fine silky webs that are attached to the undersides and margins of leaves. Affected leaves appear mottled or blotched, display stunted growth, and drop off prematurely.

Ernst introduced a biological control in the form of a predatory mite—*Amblyseius californicus*. He obtained one population from the Ceres Fruit Growers and another from the University of Stellenbosch. He has found that this is the best way to control these pests in the Kirstenbosch Glasshouse (Van Jaarsveld, 1999).

Scale

A scale insect is any homopteran insect of the family Coccidae having a flattened scale-like protective covering, and infesting and injuring various plants. Plants especially prone to this attack in growing houses are the families Apocynaceae and Asclepiadaceae, sansevierias, aloes, and some of the mesems, especially *Lithops*. The best method of control for these insects is to use a mineral oil that smothers or coats the breathing apertures of these insects and kills them in a non-toxic way.



▲ **above** *Close-up of mite;* **below** *Red Spider Mite.*

Some growers use a broad-spectrum insecticide in conjunction with the mineral oil. Unfortunately, as in the case of the mites, if you have a biological control agent in your growing house then use of insecticides will also kill off the predatory insects (Picker *et al.*, 2002; Van Jaarsveld, 1999).

▲ *Red spider mite damage on* Amaryllis *leaves showing the characteristic blotching.*

◀ *Red spider mite damage on succulents.*

▶ **opposite** *Soft Scale and attendant ants on an epiphytic orchid,* Cyrtorchis arcuata.

Thrips

Thrips are members of the order Thysanoptera of minute dark-coloured insects, typically having slender bodies and four fringed wings, many of which are pests of various plants, also called thunderbug or thunderfly.

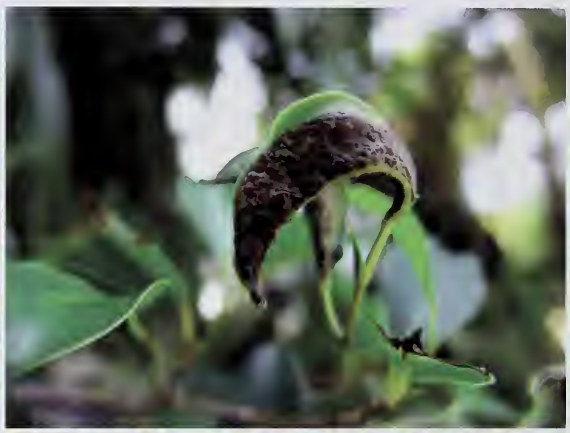
Some species are beneficial in that they will feed on mites like the red spider mite. However, they inflict damage on leaves and young fruit with their rasping mouthparts, but this is of a cosmetic nature only. The problem occurs when there is a virus in your plants—the thrips can act as a vector and spread it to other non-infected plants. Again, vigilance is the key with this like so many of the other pests.

Use a broad-spectrum insecticide to control this pest only as a last resort (Picker *et al.*, 2002; Van Jaarsveld, 1999).

Wildlife

Gardens that are situated in the wilder parts of Africa are often confronted with the potential problem associated with wildlife. Even at Kirstenbosch, porcupines visit the bulb collections from time to time. These huge rodents love bulbs and are able to clean out a valuable collection overnight. Protect your collections by either fencing them in, or growing the plants above the ground in containers that cannot be reached by animals.

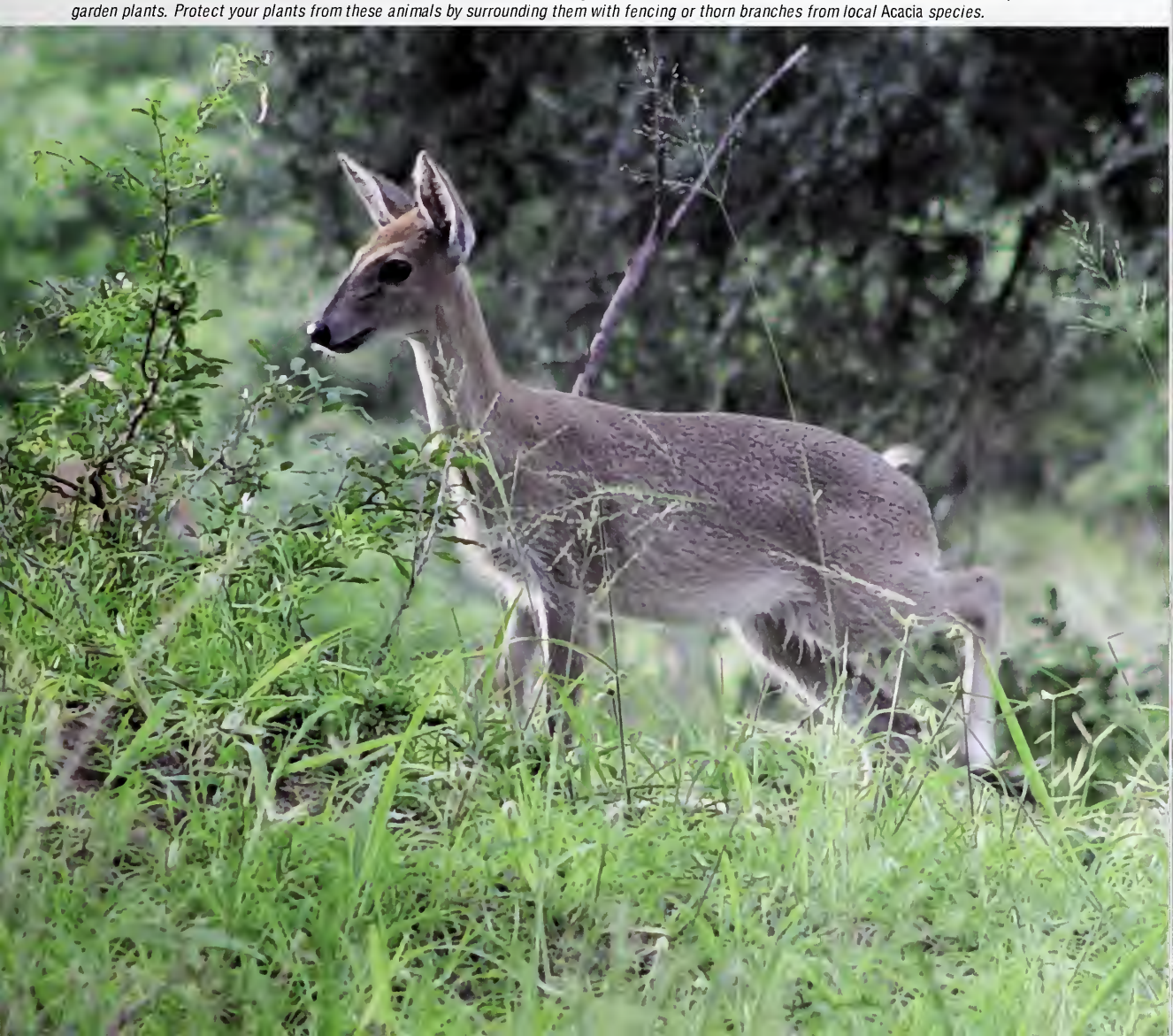
Monkeys, Grey Duiker, and Porcupine are examples of mammals that will eat vegetative growth and dig up underground storage organs like bulbs and rhizomes. The Vervet Monkey is a real problem in winter, because they come in and overturn the containers in search of grubs and worms.



▲ **top** *Fig leaves damaged by thrips;* **bottom** *A fig leaf with a section of the leaf blade cut away to expose the thrips within.*
◀ *Vervet Monkeys and other monkey species further north will overturn pots and trash a seedling bed in their search for insect grubs. If they are especially hungry in the dry season, they will eat the fruit of your plants. Note the absolute concentration on the* Erythrina lysistemon *flowers!*

◀ *Porcupine. These large rodents can destroy a bulb collection overnight.*
▼ *Bulb sowing beds at Kirstenbosch have metal frames over them to protect the plants from porcupines.*

▼ *Grey or Common Duiker. This antelope is a lover of plants in the wilder gardens of southern Africa, and will chew out the succulent tips of most garden plants. Protect your plants from these animals by surrounding them with fencing or thorn branches from local* Acacia *species.*



Chapter 2

Propagating from seed

Seed comes in many shapes and sizes. Generally, seed is grouped as follows:

- Aquatic species (discussed in Chapter 5)
- Bulb seeds
- Drift seeds
- Epiphytes, such as orchids and ferns
- Fern spores
- Fine seeds
- Fleshy seeds
- Fynbos seeds
- Hard seeds
- Recalcitrant seeds
- Winged seeds

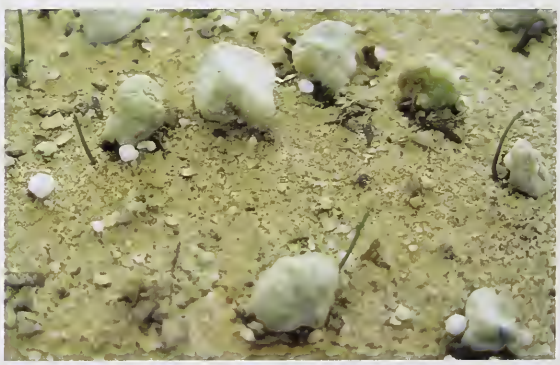
Bulb seeds

Bulbs are generally easy to grow from seed. The flat, flaky seed types need to be covered with a thin layer of seedling mix to keep them in place until they germinate. The flat, semi-winged seeds should be sown quickly or else they lose their viability. Having said this, if seed is collected when fresh and stored in a cool place at 2–4°C, it can be kept for about one growing season.

Some bulbs have fleshy seeds, which should be cleaned and sown as soon as possible. These include *Gloriosa*, *Sandersonia*, *Crocosmia*, and *Chasmanthe*. *Sandersonia aurantiaca* and *Dietes butcheriana* are two species that will only germinate after two or three seasons in a seedling tray. Do not throw out trays with these species before you have established how long the seeds take to germinate.

The large, fleshy-seeded plants like *Clivia*, *Crinum*, and *Scadoxus* will germinate quickly and some plants will even send out their root radicle before the seed has dropped off the seed head. Green seeds of genera like *Boophone*, *Crinum*, *Scadoxus*, and *Haemanthus* should be sown on the surface and not buried, so that they are able to photosynthesise.

▲ **top** *A* Gloriosa superba *"bulb" about 2 years old, showing the characteristic bend of the "bulb";* **bottom** Littonia modesta *seedlings about 6 months old.*



▲ *Germinating* Crinum variabile *seeds.*

◀ Gloriosa superba *seed ready to be cleaned and sown.*

The seed of *Siphonochilus aethiopicus* takes a season to germinate.

Amaryllids are self-fertilising, while the Irids, Hyacinths, and Former Lilies are self-sterile and need to be cross-pollinated. *Lachenalia pusilla* is one exception to this rule.

Many bulbs have contractile roots, which pull the bulb deeper into the soil as time goes by. Graham Duncan at Kirstenbosch has found that the plants flower better in a larger pot as compared to a smaller pot. Genera with large bulbs, such as *Crinum* and *Boophone*, need a pot that measures at least 400 mm across and 400 mm in depth.

Drift seed

The subject of drifting seed has intrigued me all my life. Drift seed is carried down rivers and deposited into the sea, or scattered directly into the sea from plants growing on beaches. In our part of the world, legumes are the most common bearers of viable seed. The most dominant legumes include *Caesalpinia bonduc*, *Entada rheedii*, and *Mucuna gigantea*. Although one tends to think of mangroves first, it is mostly seeds of these large, leguminous creepers and trees that seem to undertake the long sea journeys. It would be quite possible to build an interesting collection of drift seed plants near the sea in Angola and Mozambique.

Two famous palms let their seeds drift around the world looking for the ideal place to take root. The first, well-known palm is the Coconut (*Cocos nucifera*) and the other is the Coco-de-mer (*Lodoicea maldivica*), an endemic palm from the island of Praslin in the Seychelles Archipelago.

Another example of a drift seed bearer is the Mozambique mangrove or *Heritiera littoralis* (Sterculiaceae), common all along the coast into South Africa. An interesting example of adaptation exists in the case of mangroves where vivipary or pre-germination ensures survival in difficult habitats. Seed germinates and a spear-shaped root develops while still on the parent plant to ensure survival in these waterlogged habitats. When the time is right, the seed drops into the mud below and is able to grow immediately.

Many coastal dune pioneers undertake only short sea journeys. Examples of species that follow this dispersal mechanism include *Canavalia rosea*, *Sophora inhambanensis*, *Ipomoea pes-caprae*, *Scaevola plumieri*, and *Scaevola sericea*.

▲ **top** Boophone haemanthoides *enjoys pots that are at least 400mm deep;* **bottom** Boophone *plants in a large pot.*

▲ **inset** *A selection of the drift seeds that wash up on the shores of southern Africa.* Entada rheedii *(large, reddish and flattened),* Caesalpinia bonduc *(blue-grey), and* Mucuna gigantea *(smaller reddish brown and flattened);* **main photo** *Drift seeds on the beach in northern KwaZulu-Natal near the Mozambique border.*

Propagation

The best method of breaking dormancy is to scarify the seed coat and soak the seed in water for a day or two until it starts to swell (see Hard Seed later in this chapter for more detail). After parts of the testa have been ground, soak the seeds overnight or for a couple of days to induce the germination process. Once the seed has started to swell and split, but before the root or radicle appears, place the seed into the seedling mix for the rest of the germination process. Before sowing the seed, wash off any excess wax or jelly-like substance from the seed coat to get rid of inhibitors that might still be present in these substances. This substance also holds water, which can lead to fungi gaining access to the vulnerable germinating seedling.

▲ Ensete ventricosa *seed germinating in a seedling bed.*

Seed could be soaked in a cloth or nylon bag placed in a flowing river or stream, or under a running tap. The aim of this method of washing seed is to mimic the effect of floodwater, or a river carrying seed along. This method of washing the seed removes any inhibitors in the seed coat. It also softens the seed coat to allow water into the cotyledons to start the germination process. This process could take as long as two weeks. Experimentation is what is important in this instance—by keeping accurate records of these methods, others may benefit from the lessons learnt.

Ferns

by Koos Roux

Ferns and allied plants occur throughout the world, from the remotest sub-Antarctic island to extreme altitudes in montane regions. Although they are more common in the moist tropics, many species have evolved to occupy specific niches. Sufficient moisture and light are important for any fern in a particular habitat. The amount required depends on the species.

▲ Acrostichum aureum *plant in a marsh.*
▶ *Fertile and infertile fronds of* Stenochlaena tenuifolia.

Ecology

In the tropics, growth forms are varied, some being confined to terrestrial habitat while others are exclusively epiphytic. In *Platycerium* (staghorn ferns) and *Drynaria*, both epiphytic, the fronds are strongly dimorphic. The sterile basal fronds form a basket, which the plant uses to trap humus and moisture. In others, the fronds or pinnae are articulated to short phyllopodia on the rhizome or rachis. In the event of drought, the fronds or pinnae of these plants may be shed.

In *Stenochlaena tenuifolia*, a species associated with coastal forests, the plants will not produce fertile fronds unless the rhizome ascends a tree, sometimes as high as 10 m. Only when the apical region is exposed to sufficient light in the upper reaches of the tree will it produce fertile fronds. Few forest species will grow in very deep shade. The tendency is for them to grow where there is a break in the canopy, such as along streams, where sufficient light reaches the forest floor.

While some species are restricted to the wet tropics, others are confined to seasonally dry habitats. Species growing in these habitats have subterranean rhizomes and the usually finely dissected, often leathery fronds die down during the dry season. *Asplenium cordatum*, generally associated with dry habitats, has fronds that are densely covered by large scales on the lower surface of the lamina. The fronds of these plants generally curl up during dry spells, the scales keeping them from becoming completely desiccated. When the plants receive sufficient moisture the fronds unfold and growth continues.

Acrostichum aureum is unique—it has the ability to grow in estuarine habitats regularly exposed to seawater. *Ceratopteris*, *Marsilea*, *Azolla* and *Salvinia* are also aquatic, but restricted to fresh water. *Bolbitis* species are generally associated with water and the rhizome, which is anchored in rock crevices in and along streams, produces fronds submerged in running water. Fertile fronds of these plants, however, are produced above the water level.

Ferns growing in grasslands and montane regions are regularly exposed to veld fires. Species occurring in these habitats generally grow in rock crevices or at the base of rocks where they receive some protection. In addition, the rhizome is subterranean, and although the fronds may be destroyed, the rhizome appears to be unaffected by fires.

Life cycle

Ferns and fern allies reproduce either asexually (vegetatively) or sexually.

Vegetative reproduction usually takes place by means of their rhizomes, but in several species, proliferous buds are formed on the fronds. These buds often become detached and, if the conditions are favourable, give rise to a new plant; *Tectaria gemmifera* is an example. In sterile hybrids, rhizomatic reproduction is essential.

▲ **left** *Bulbils developing on the top surface of a* Tectaria gemmifera *leaf;* **right** Platycerium elephantotis *(Polypodiaceae), the epiphytic staghorn fern, growing on a tree along a river bank in Zambia (Photo: P.S.M. Phiri).*

(Continued on next page)

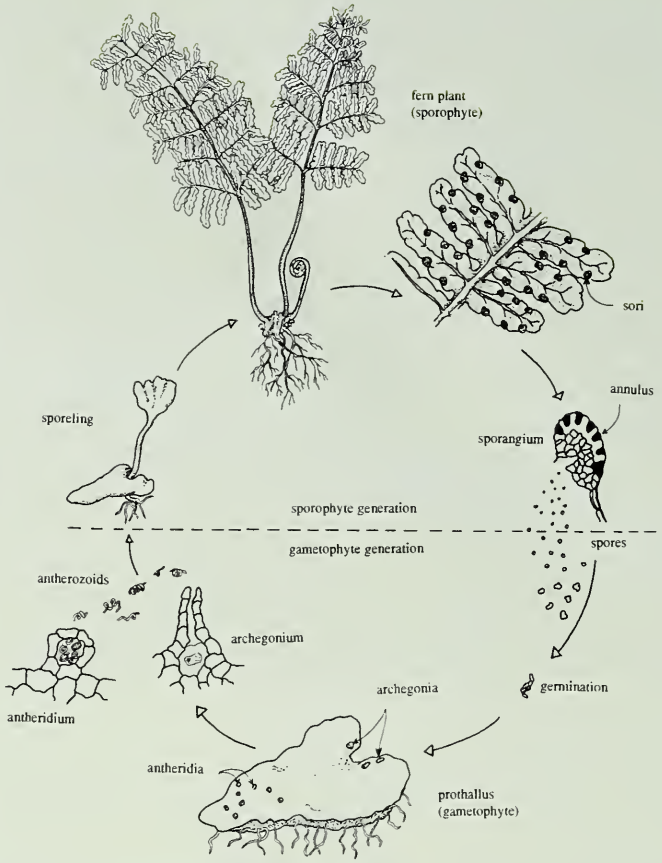
Sexual reproduction in ferns and fern allies is more complex. The cycle starts when the mature fern plant produces spores. Spores are borne in sporangia, which in turn are generally grouped into sori, which may take on various forms in true ferns. Sori are borne abaxially on the frond of the sporophyte. Within the sporangium, the spore mother cells go through various mitotic and meiotic divisions to give rise to the spores.

When the spores are dispersed, some may end up in a habitat with suitable moisture and light. The tiny single-celled spores now start to grow by cell division to eventually form a small heart-shaped plant or gametophyte (prothallus). The prothallus, usually about 10 mm in diameter, is an independent plant with its own rhizoids to provide it with nutrients and water.

The sexual organs (gametangia) are borne on the lower surface of the prothallus. The male organ (antheridium) produces spermatozoids and the female organ (archegonium) an egg cell. The spermatozoids need to swim to the archegonium through a water film for the egg cell to become fertilised. Once fertilised the egg cell begins to grow within the archegonium to form an embryo. The embryo eventually gives rise to a new sporophyte—the ferns we all know.

In heterosporous ferns and fern allies, the male spores (microspores) will give rise to a microgametophyte and the female spores (megaspores) to megagametophytes. For sexual reproduction to take place in these plants, it is essential that the spermatozoids reach an egg cell on a different prothallus.

Ferns in many parts of the world grow in dry climates where water is not always freely available. Gametophytes growing in these habitats have overcome the obstacle of fertilisation by producing a sporophyte from the egg cell without it being fertilised. This phenomenon is known as apogamy.



▲ *The life cycle of a homosporous fern.*

Vegetative propagation

The structure of the rhizome in most fern species allows them to be propagated through division. The plant can simply be lifted and the rhizome divided into suitable, not too small, sections. Always ensure that the rhizome tips remain intact. Smaller species with thin unmanageable rhizomes grown in pots can simply be removed and halved.

Several spleenwort *(Asplenium)* species are proliferous; they produce young plants at the base or apex of the lamina. A small pot containing a suitable soil mixture can be placed under each of these fronds and the small plant, still attached to the mother plant, pinned down onto the soil in the pots. Once well established they can be removed from the mother plant by cutting the rachis.

Tectaria gemmifera produces numerous bulbils (gemmae) on the adaxial surface of the lamina. When mature, these bulbils are shed and can be collected. They can be placed on the surface, or slightly pressed down into a suitable soil mixture, but not covered. They must be kept moist, preferably in a well-shaded position. These bulbils are quick to produce fronds.

Propagating from spores requires patience. Spores are ready to be collected once the sporangia have turned black. Some may already have started shedding their spores—these sporangia will turn brown. This can easily be observed with the aid of a X10 hand-lens. Remove a fertile frond or a few pinnae and place them in an envelope to collect spores. The envelope containing the lamina part should be left in a dry place for about a week, after which it can be removed leaving the powdery spores at the bottom of the envelope.
—Dr Koos Roux, Kirstenbosch

Propagation by spores

The container and growing medium in which the spores are sown should ideally be sterilised to minimise the risk of contamination by fungi. Use containers that allow good drainage. Place vermiculite or fragments of perlite in the bottom of the container, preventing the drainage holes from becoming blocked. Fill the container with a well-decomposed leaf mould or peat and press down firmly. Pour boiling water over the container and growing medium to sterilise it. Allow the container to cool and the excess water to drain. Once cooled, the spores can be sown.

Cut a section of blotting paper or any other piece of coarse paper to the size of the container. Sow the spores on the paper and spread evenly.

Return excess spores to the envelope. Gently turn and place the paper with the spores stuck to it face down onto the medium. Tap the paper to release the spores onto the growing medium. Cover the container with transparent plastic and keep it out of direct sunlight at room temperature.

The spores of most species begin to germinate within a few days or weeks, producing the flat, heart-shaped prothalli. Keep the surface of the soil shiny-wet, using a fine spray and preferably distilled water. This level of wetness must be maintained to allow the spermatozoa to swim to the archegonia for fertilisation to take place.

Once the young sporophytes have emerged, remove the plastic cover to enable the young plants to be hardened off. Care must be taken that the soil does not dry out. Once the young sporophytes have reached a manageable size and are well hardened off, they can be pricked out into separate containers.

▲ **left** *Fern spores covered in a plastic bag to keep in moisture once spores are sown on the growing medium;* **right** *Fern spores in a pot with germinating prothallus.*

IMPORTANT

Care must be taken that the soil does not dry out.

Cultivation

Ferns are relatively hardy plants and can be successfully cultivated if a few basic rules are applied. It is best to always try to mimic the conditions in which the plants grow in nature.

- Never allow the plants to dry out.
- Do not allow the growing medium to become water-logged.
- Air movement is necessary, but avoid draughts.
- Feed regularly during the growing season.
- Grow the plants in strong, filtered light.

When growing the South African tree fern *Cyathea dregei*, ensure that the plant has wet feet and is growing with its fronds in full sun. The reason why so many of these ferns are killed in cultivation is that they do not get enough light. *Cyathea capensis*, on the other hand, wants to be in a cool temperate forest climate growing in plenty of light but not full sun all day.

Growing medium

Soil must be properly prepared before planting ferns in the garden. Work in large quantities of well decomposed manure, compost, or bark. Coarse sand should also be worked in to a depth of at least 0.5 metres where the natural soils tend towards clay or heavy loam. Ferns have a shallow root system and will seldom reach deeper than this. Bone meal can also be added. Aim for a pH of 6 or 7.

For container cultivation, use a well-drained humus-rich medium. I like to use compost derived from broad-leaf clippings or grass clippings and not the commercially available pine-based composts. They are often too acid and not properly broken down. My most successful mix is 2 parts compost and 1 part river sand (as coarse as possible), with fertiliser—100 g of bone meal with 50 g of Dolomitic lime, and 50 g of single superphosphate per one flat wheelbarrowful of the medium.

Watering

Watering is perhaps most important for successful fern cultivation. The soil must always be kept moist, but not wet and never saturated. The frequency depends on the growing medium, where they are grown, and the prevailing weather conditions. As most species like a high humidity, a daily misting during the warm summer months can be beneficial. This is best done during the morning or in the evening and not during the heat of the day. A good mulching will also help in retaining water, keeping the soil cool, and raising the humidity.

Feeding

Ferns respond well to regular feeding, although this should be restricted to the active growing season. Avoid using granular inorganic fertilisers, but Osmocote—a slow release granular fertiliser—can be used. Organic liquid fertilisers are preferable, either as a foliar feed or for wetting the soil.

I find that ferns require no feeding during the cooler winter months. Let the plants rest and only begin applying fertiliser again when the new growing season begins in spring.

Pests and diseases

Ferns are not pest free—they can be damaged by snails, slugs, and caterpillars. Indoors, mealy bug is a common pest. Watering the plant with Metasystox R, a systemic insecticide, can prevent this and damage from other sucking insects. Frond-eating insects can be exterminated with the wettable powder, Karbaspray. Always avoid spraying during the heat of the day.■

▲ Cyathea dregei *in an upland vlei in the Qudeni Forest, KwaZulu-Natal.*

▲ Streptocarpus *seed capsule.*

Fine seed

Forest-dwelling species often produce small seeds, for example, *Streptocarpus* and *Begonia*. High altitude and high rainfall, coupled with frequent mist, are characteristic features of cooler forests, and provide ideal habitats for moisture and humidity-loving plants. An example of this abundance is found in forest trees, where loads of epiphytes thrive.

▲ Begonia dregei *seedlings showing the very spotted leaves of juvenile plants, which are different in shape and spotting from the mature leaves.*

Collecting

The extreme humidity of these habitats requires that seed is collected directly from the plant and capsules can be collected while still a little unripe. Capsules are ready for harvesting as soon as they change from green to a straw colour, and when they are swollen and rounded in shape—not angular. Seed collected in this way is uncontaminated. Drying should take place under controlled conditions at home or in the nursery.

If you want to store seed, keep it in a cool, dry place. Keep in mind, however, that it is best to sow the seed fresh.

Sowing

Use a seedling mixture that consists of 1 part finely sieved compost and 1 part coarse river sand. Don't add any fertiliser to this mixture; otherwise, too many pathogens will germinate.

The capsules split open if left in a small, clean paper envelope. Sow the seed very lightly to scatter the individual plants sufficiently. In this way, the seedlings can develop on their own without too much competition for space from their neighbours. Sparse sowing also enables one to lift out any diseased plants with ease, thus preventing fungal infestations from spreading to other plants in the tray.

The best way to keep seed damp is to cover the shallow trays with a sheet of glass, which will keep the moisture in and prevent heavy watering from displacing the freshly sown seeds.

▲ **left** *Grass seed mainly falls into the fine seed category. Here the seed can be seen germinating in shallow seedling trays kept at a high temperature of 30°C;* **middle** *The collection of* Senecio medley-woodii *with Mark Gillmer in the Bridgevale Municipal Nursery in Durban;* **right** *Collecting* Senecio medley-woodii *seed.*

▲ **left** *Under-watering using a wheelbarrow as a container;* **right** *In this way, the mixture sucks up the moisture from beneath.*

TIP

You can use clear plastic bags such as oven bags to keep moisture in the little microclimate. Keep the young seedlings cool after germination to discourage attack from pathogens.

In the absence of a sheet or other form of cover, the seed floats out of the tray into the surrounding seedling area where it germinates a lot more successfully than in the trays. The drawback, however, is that if one is sowing many different species, the mixing of seedlings can become a nightmare!

Watering

Keep in mind that these plants are delicate. It is best to water the trays from below to allow water into the tray by partially immersing the tray to about half its depth in a pool of water in a wheelbarrow or larger tray or basin. The water soaks up to the roots of the young plants by capillary action. This reduces the risk of splashing out plants and bruising the leaves with heavy drops of water—the cotyledons or seedling leaves are no more than 1–2 mm in diameter after germination.

Fertiliser

Once the cotyledons have developed and the new proper leaves are forming, a little fertiliser in liquid or soluble form in low concentrations can be applied to boost the young plants. Initially, organic fertilisers are the best option; use half the dilution ratio as it appears on the label of the container. As with watering, apply fertiliser (in liquid form) from underneath.

Apply fertiliser every ten days or so in the growing season. Reduce the amount of watering once winter starts towards the end of March to mid-April. After that, stop feeding the plants altogether.

Transplanting

Keep the seedlings in the original tray until after the first winter or dormant season. The young plants go into suspended animation for a few months until the onset of spring in August or September. The further inland and higher in altitude, the greater the delay before plants start to grow in the spring. The delay can be 4–6 weeks. Only once the new growing season has started should it be necessary to prick the young plants out into individual pots, or transplant them to the garden.

Fleshy recalcitrant seed

Many of the plants in the subtropical parts of southern Africa produce fleshy fruits to make them attractive to the fauna on which they rely for seed dispersal.

The plants have developed all sorts of tricks like the colour, texture, and taste of their fruits to attract a dispersal agent. As a propagator, one has to observe what methods are used in nature and attempt to duplicate the cycle so that the seed will germinate.

I advise that the ripe fruit of all these fleshy-fruited and large-seeded plants is collected, cleaned, and sown within a day of collection. Do not dry the seed out at all, as the loss of viability is caused by the loss of moisture.

The edible fruit of the Marula (*Sclerocarya birrea* subsp. *africana*), the Mahobohobo or Muzhanje (*Uapaca kirkiana*), and the umDoni or Water berry (*Syzygium*

cordatum), have to be eaten by animals to prepare the seeds for germination. Once swallowed, it takes about 8–16 hours for the seed to pass through the gut of the animal. During this time, the seed is subjected to the digestive juices in the stomach. This process often removes inhibitors.

The soft seed of *Warburgia salutaris* will germinate within 14 days if unparasitised fruit is collected.

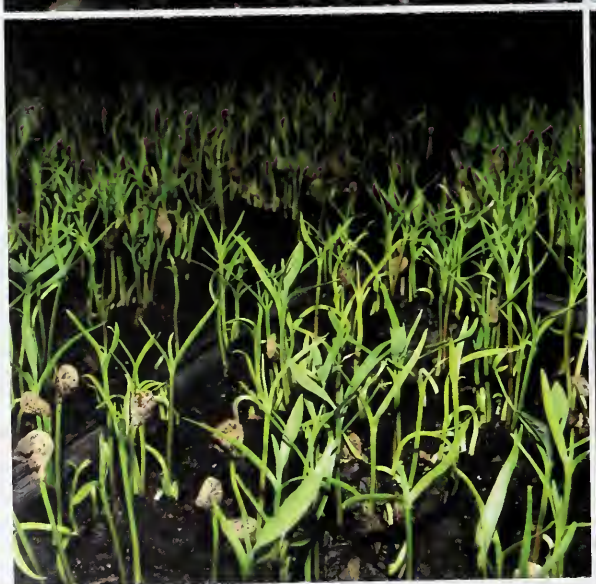
Other examples of species grown successfully from fresh seed include *Trichilia emetica*, *T. dregeana*, *Protorhus longifolia*, *Syzygium cordatum*, *S. pondoense*, *Gymnosporia maranguensis*, *Englerophytum natalense*, *Manilkara discolor*, *M. mochisia*, *Halleria lucida*, *Pappea capensis*, *Berchemia discolor*, *B. zeyheri*, *Deinbollia oblongifolia*, *Pancovia golungensis*, *Blighia unijugata*, *Ochna serrulata*, *O. natalitia*, *Rhus* species, *Haplocoelum foliolosum*, and *Chrysophyllum viridifolium*.

A great deal of pioneering work has been done on storing these recalcitrant seeds in liquid nitrogen, but this type of storage is best left to large laboratories and institutions with the resources to maintain these systems. Our role is to help supply these projects with seed of our threatened species.

Fynbos seed

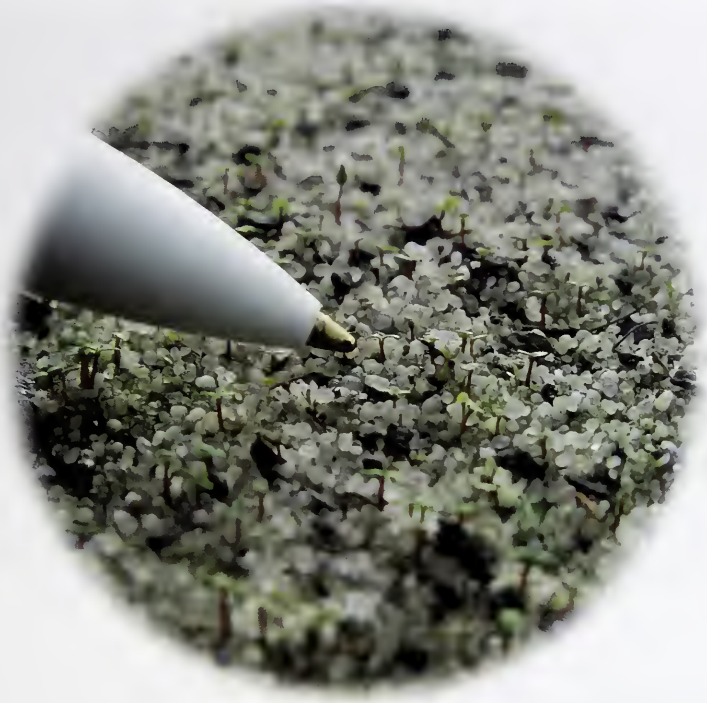
Seed of Proteas, Ericas, Restios, and Buchu or *Agathosma* ripens during summer and should be sown in autumn.

Fynbos plants need acidic soil to thrive. The optimum



▲ **top left** Ochna barbosae *seed being cleaned. The seed should be sown immediately after the flesh has been rubbed off;* **top right** *Young* Warburgia salutaris *fruit stung by fruit fly on cultivated trees;* **bottom left** Warburgia salutaris *seedlings a few days old. The cotyledons are very thin and the seedlings look like conifers rather than dicots;* **bottom right** Syzygium legatii *fruit ready to be harvested. After stripping off the flesh, sow immediately. The chlorophyll-rich cotyledons need to be exposed to light for germination to occur, so seed should not be covered, just pressed into the soil mix.*

▲ Pancovia golugensis *fruit ready for harvesting.*
▼ Blighia unijugata *fruit showing the fleshy yellow aril surrounding the black seed (Photo: Gareth Chittenden).*



▲ Erica *seedlings germinating.*

pH for the seedling mix is 4,7–5,0. Apply smoke treatment—this imitates the effects of a fire in a fynbos area. (See "Hard Seed" later in this chapter for details).

Sowing

Sow the fine seed of Ericas and other fynbos plants sparsely over a level surface in the seedling tray. This allows enough space between seedlings to develop freely and minimises the spread of fungi and other pathogens. Place the trays in full sunlight and make sure that the area is well-ventilated.

Watering

Good drainage is vital to grow fynbos seedlings successfully. The general principle of watering plants in the morning before the sun warms an area is also applicable to seedlings. At this time of day the water is applied at more or less the temperature of the soil—this evenness of temperature helps to keep fungi at bay.

The best method of watering is by drenching the seedling containers or trays. The water is soaked up from the bottom, which prevents damage to the seed. This method also prevents seed or germinating seedlings from becoming dislodged. The Australians call it "bog-watering".

- Place the tray in a pan of water that nearly reaches the lip of the tray. The soil absorbs the water until it is saturated.
- Once the seedling mix is saturated, remove the tray and allow the tray or trays to drain and dry out for a day or two.
- It is preferable to use deep trays for seedlings. The soil moisture in a deep tray tends to be more constant and decreases at a slower rate than in a shallow tray.

If you have to use overhead watering for seed, use a watering can with a fine rose. The person responsible for performing this task should be well-trained.

Repotting

Seed germinates in about 1–2 months. Once the seedlings start sending out roots, they can be pricked out into the open ground, or into individual plastic tubes, packets, or fibre containers. Gradually wean the young plants by providing light shade and careful, regular watering—these are crucial requirements for their survival. If plant production and profit are not the driving forces, transplant or re-pot the plants only when it is cool and overcast or rainy. Re-potted plants love rainwater, which gives them a boost, encouraging rapid growth.

Another way of introducing plants back into the wild entails sowing seeds directly into the veld—instead of planting out mature plants grown in the nursery—thus allowing natural selection to continue. This also prevents fungi and other pathogens that occur on fully grown plants or in the soil that comes with them from the nursery from being accidentally introduced into areas where an attempt is being made to re-establish populations of threatened plants.
—Andrew Hankey, Walter Sisulu National Botanical Garden

◀ **opposite** Agathosma ovata *can be grown from both cuttings and seed in the winter rainfall region.*

▲ **left** *Abrade seed by rubbing it against emery paper (sand paper tends to break up)—rub the seed against the rough paper until the cotyledon begins to show. Shown here are* Erythrina caffra *(red seeds),* Erythrophleum lasianthum *(small flat round seeds),* Entada rheedii *(large brown seed),* Mucuna gigantea *(brown),* Dioclea reflexa *(speckled), and* Caesalpinia bonduc *(grey-blue);* **right** *After scarification and soaking, the seeds are ready to be planted. Note how much the seeds on the right have swollen compared to their original size on the left.*

Hard seed

Seed of *Acacia*, *Erythrina*, *Erythrophleum*, and *Elephantorrhiza* are examples of hard seeds that need to be scarified to germinate successfully. I always soak my seeds in room temperature fresh water after scarification to ensure that they are swelling before finally sowing them.

Abrading

Abrading is a form of scarification using sandpaper, rough emery, or even a grindstone to remove part of the seed capsule to aid germination. Sometimes the seed capsule needs to be cracked using a vice or pliers.

Some hard seeds have a fleshy outer layer that may be soft, like *Harpephyllum caffrum* or *Encephalartos* species, which is relatively easy to remove. However, other species, like *Chaetachme aristata* or *Cassine transvaalensis* have a solid or harder outer layer that needs to be removed to expose the seed within. To remove this can be a tedious task.

This is where electricity and the modern food processor (or blender) come in handy. Put about 30–50 fruits in the blender with about a cup of water. Press the button in spurts of 5–10 seconds, two or three times. The flesh will be chipped off the seed.

TIP

Do not rub too much of the seed coat off, as this will allow pathogens to attack the cotyledons. Remove just enough to let water get in to start the germination process.

Nicking

Nicking is a modification of abrading and entails the removal of a section of the seed coat of larger seeds with a sharp knife. Remove the end that is opposite the "eye" or hilum. In KwaZulu-Natal, the seed of *Turraea obtusifolia*, *Euclea natalensis*, *E. racemosa*, *Diospyros villosa*, *D. natalensis*, all *Strelitzia* and *Erythrina* species, as well as a few of the *Eugenia* species, would benefit from nicking (Wray, 2003).

▲ **top left** *Seed of* Erythrina *species;* **top right** *Nicking seed of* Erythrina lysistemon*;* **bottom left** *Seed swelling in water;* **bottom right** *Seed after 24 hours and beginning to send out the radicle.*

Tension

Some plants, such as euphorbias, generally have hard capsules, within which, once mature and dried out, a tension is created causing an explosion that scatters the seeds away from the parent plant. Collecting *Euphorbia* seed is best done by picking the ripe fruit. This process can be tricky, given the sharp spines and corrosive latex that can cause severe irritation, should it encounter one's eyes.

WARNING

Wear protective goggles and leather gloves when collecting *Euphorbia* fruit.

Once the capsules have been collected, place them in a paper or cloth bag. Leave the bag in a dry, warm place to dry out. The bags will seem to come alive when the seeds are ripe and start exploding! When all the seeds have been set free, file the seed coat a little and sow it in a tray of seedling medium. Seeds should germinate after about 14 days, if the weather is warm.

Heat treatment

Heat treatment of seed could also be attempted to aid germination. Heat treatment entails baking the seed in a microwave oven. *Acacia* seed needs about 2 minutes of treatment according to some sources (Stewart, 1999). Small seed should therefore only need a few seconds of this kind of treatment to be effective. Again, this is about experimenting with different techniques, so I recommend using small quantities of seed at a time to prevent unnecessary waste.

Many African plants grow in fire-maintained systems, such as grasslands. Certain species may therefore benefit from scorching the seed with a grass fire. Place some seed on the ground and cover it with enough grass to burn for approximately a minute. Remember to use small quantities of seed in the process of perfecting your technique.

Some Protea seeds will be trapped inside the hard cones for a full season before they are released. Generally, the heat of fire causes the cones to split open and release the seed. Placing collected cones in trays lined with newspaper in the hot sun for a few days, can mimic this stimulus. Not long after, the cones will split open and

▶ *One-year-old* Euphorbia bupleurifolia *seedlings in cultivation.*
▼ *Seed capsules of* Euphorbia bupleurifolia *plants in cultivation.*

▲ **left** *Smoke in the hills (Photo: Neville Brown);* **middle** *Smoke drum and tent (Photo: Neville Brown);* **right** *Smoked* Calopsis paniculata *seedlings.*

release their seed. Before sowing the seed, refer to the next section on smoke treatment.

Some people recommend soaking leguminous seed in near boiling or hot water to ease germination. Experiment with a few seeds first to get the technique right. When seed germination becomes apparent, use the technique to do a larger batch of seed.

Wash off any gelatinous, jelly-like substance in clean, cold water by rubbing the seeds together gently after the soaking process has been completed.

Smoke treatment

A technique pioneered in South Africa in about 1990 is the use of smoke to break the dormancy of seed. Much has been written about this practice. What follows is a short summary of the principles of the method.

Using smoke to break seed dormancy was pioneered in the winter rainfall areas of the southern Cape, where periodic fires sweep through the fynbos and researchers observed that certain species of the Protea, Restio, and Daisy families responded by germinating in the bare soil left after a fire. This discovery motivated experimentation with other species. It was found that the chemicals in the smoke penetrate the seed coat, either in its airborne form, or in a solution when the smoke chemicals are washed over the seed, thereby breaking its dormancy after the first winter rains.

Over the past few years, the smoke treatment method has been simplified—fynbos plants are placed in a large 200-litre drum and air is added via a bellows system or a compressed air line. The plants are set alight in the drum and the resulting smoke is blown into a tent that has been placed over the trays of seed.

The seed is left in this state for an hour or two, then the trays are removed and the chemicals are washed into the soil. This method is suitable for large quantities of trays.

If you are a domestic grower of fynbos plants, buy the Kirstenbosch Instant Smoke Plus Seed Primer (see the inside back cover for details of suppliers). This kit consists of a filter paper disc impregnated with the chemicals found in the smoke of burning fynbos. Pour 50 ml of water over the disc into a cup and soak the seed you wish to germinate in the smoke water for 24 hours. To date, over 200 species of plants tested using this method of treatment have shown positive results. It has become standard practice in most of the winter rainfall regions of the world to stimulate seed germination by using smoke treatment.

Cool chilling

For high-altitude montane species, a method known as cool chilling may be needed to stimulate seed to germinate. Simply place the seed in an airtight bag or container with damp sand or vermiculite, perlite, or sphagnum moss. Store the seed in the bottom of a fridge or in a cool room at a temperature of between 2–4°C for a period of about 3–12 weeks. The length of time that the seed is stored, or rested, should mimic the length of the winter period of a particular climate. Sow the seed in spring. Seed that has been allowed to rest well, should germinate more readily.

▶ *A diagram showing a method of introducing seeds to smoke. (Drawing: Len Jones.)*

A similar treatment for dryer, warmer climates is to store seed in a dark, dry container that mimics the conditions of a dry forest floor. Again, the period spent in this kind of storage depends on your particular climate's resting periods.

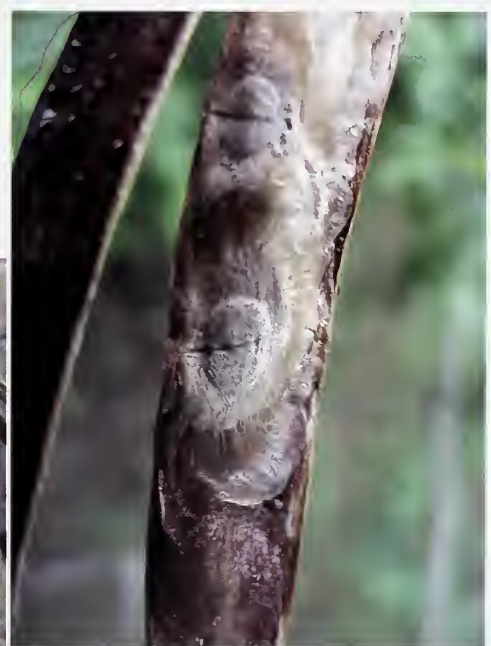
Certain commercial seedling growers aerate the water used to soak seeds before sowing. This is a skilled operation and is only useful when executing large-scale operations. It doesn't, however, meet the needs of general propagators.

Winged seed

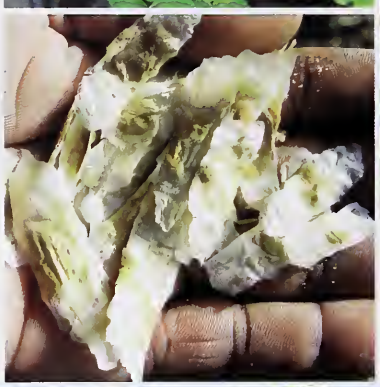
Many of our plants produce "wings", which make wind distribution possible. Examples of plants with this feature include *Atalaya*, *Combretum*, *Markhamia*, *Pterocarpus*, *Stereospermum*, *Terminalia*, *Entandrophragma caudatum*, and *Tecoma capensis*.

Crack and rough up the winged testa of these seeds by rubbing them together with your hands. The immediate effect of this action is to reduce bulk.

▲ Combretum zeyheri *and* Pterocarpus angolensis *seed waiting for rain.*
◀ Combretum zeyheri, *largest of the winged* Combretum *seeds in South Africa.*



▲ Tecoma capensis *showing winged seed.*
◀ Pterocarpus angolensis *seed.*



▲ Fernandoa magnifica *flower.*
◀ **top** Fernandoa magnifica *seedlings, about a week old;* **bottom** Fernandoa magnifica *seed showing the typical winged seed of the family Bignoniaceae.*
▼ Fernandoa magnifica *in flower in the Arabuko Sekoke Forest in Kenya.*

Parachute seed

Families that employ this airborne method of dispersal in the form of a parachute, rather than a structural wing, include some Proteaceae, Asteraceae, Apocynaceae, and Asclepiads. The parachutes are finely haired and float off in the wind.

In the case of Asteraceae, insect seed predators can damage the whole flower head, because the seeds are so closely packed together. Study the seed heads carefully and pick only the sound ones. I prefer to gather the seed while it is still a little unripe. This allows me to handle more seed in a smaller compartment, rather than deal with only a few ripe seeds, which have split in the seed head and become bulky.

With both Asteraceae and Apocynaceae, I prefer to collect the follicles as they start to split. This prevents the silky haired parachutes from spreading into every corner of your backpack or collecting kit. They are relatively safe from attack by predators, because of the milky latex that many of these plants produce.

These plants germinate relatively easily and they can be stored for about a year under normal room conditions, as long as a small quantity of insecticide or fungicide is placed in the storage containers.

A simple and effective, non-toxic (to humans), method of keeping insects at bay is to place well-ground, grey wood ash from a fire in with the seeds. An old Zulu woman, who stored her maize in this way, taught me this method. Use about one part ash to two parts seed by volume. Shake the mixture together to allow the ash to mix properly with the seeds in the container.

◀ **top** *These* Raphionacme hirsuta *follicles are almost ripe—the colour changes to a darker shade when ripe;* **middle** Gerbera aurantiaca *seed. (Photo: Isabel Johnson);* **bottom** Adenium obesum *seed showing parachute hairs at both ends of the seed.*
▼ Mondia whitei *follicle shedding seed. Seed of the Apocynaceae family often have the flattened look of rolled oats or wheat. Look for this pattern and you'll know the family of seed floating past on its silken parachute. Seed in South Africa is ripe in late August just as the summer rains begin.*

Chapter 3

Vegetative propagation

SOME PLANTS PROPAGATE BETTER VEGETATIVELY THAN FROM seed. This chapter deals with different kinds of vegetative propagation in detail.

Soft-tip cuttings

Most plants with a soft, herbaceous growth habit are worth trying to propagate using soft tip cuttings. Many plant families provide visual clues as to whether they will root or not, for example, adventitious roots formed at the nodes.

- Cut a shoot that includes the first four nodes: two nodes for the shoot and two nodes for the roots.
- Trim off about half to two thirds of the leaves and use a sharp knife to cut the stem below the base of the lowest node at right angles to the stem.
- Dip the cutting into rooting hormone used for rooting softwood cuttings. (Examples of softwood or herbaceous plants that root without rooting hormone are *Plectranthus* and *Impatiens*).
- Make a hole in the rooting medium with a dibber.
- Place the cutting in the hole and tamp the medium back firmly against the stem.
- Water the cutting to help settle it down and wait for it to root. Depending on the plant species, rooting time varies from about ten days to a few weeks.
- Keep damp at *all* times under a mist system or under waterproof sheeting.

▲ *Preparing a soft-tip cutting of* Gazania rigens
◀ *Cutting of* Plectranthus *being placed into florist foam for rooting.*

Hard-wood cuttings

Most shrubs and trees can be propagated from cuttings. It is preferable to take evergreen plant cuttings at the beginning of the growing season, during spring or early summer. Deciduous plant cuttings should be taken before the end of winter, when the sap is rising, and the buds are about to swell.

Deciduous cuttings should be rooted in a protected, but not too moist environment, such as a cold frame. Evergreen cuttings can also be rooted in cold frames, as long as the stems are not too soft. Cuttings should be taken from healthy shoots from the previous season's growth. Choose cuttings that are about as thick as a pencil, but not thicker than your finger. Set these according to the same principles as soft tip cuttings.

A giant form of hardwood cutting is called a truncheon. This is a large branch with a diameter of more than 40 mm. This method works very well for succulent plants and certain tree families, including Anacardiaceae, some Fabaceae, Euphorbiaceae, Burseraceae, and Bombacaceae.

In rural areas where piped water is a luxury, this is the best way to propagate figs. I have observed this method of propagation successfully applied to figs and other trees, such as the Marula (*Sclerocarya birrea* subsp. *caffra*), the Powder Puff Tree (*Barringtonia racemosa*), and the Coast Coral Tree (*Erythrina caffra*). The Common Coral Tree (*Erythrina lysistemon*) and Wood's Corkwood (*Commiphora woodii*) are used for fencing posts.

The best time to use this method is in late winter or early spring. Root establishment can take up to a full growing season. Bury one-third of the truncheon in soil, while leaving two thirds exposed to produce new growth.

▲ **top** *Heel cutting showing the stripped "heel" when pulling the side branch off the parent plant;* **bottom** *Leaf cuttings of* Haworthia *(left) and* Gasteria *(right).*
▼ Commiphora woodii *truncheons used as fence poles.*

▲ *Leaf cutting of* Haworthia *growing out as a new plant.*

Heel cuttings

Heel cuttings are often the most successful type of cutting for the propagation of shrubs and trees. This form of cutting involves removing a short, actively growing, side shoot from the main stem. A side shoot is torn off the supporting (main) stem and a part of the main stem is left attached to the base of the cutting. This is called the heel. The roots will appear at the callus tissue that forms around the heel. Again, the process of setting these cuttings is similar to the process followed for hard and soft cuttings.

Leaf cuttings

Some families will produce roots from leaves. This is a slow method, but does work with a little bit of patience. It is important to let the wound at the leaf-base dry before planting the cuttings in coarse, well-drained river sand. Another method is to place the leaves on the surface and let the roots develop above ground. Do not keep the sandy medium too wet.

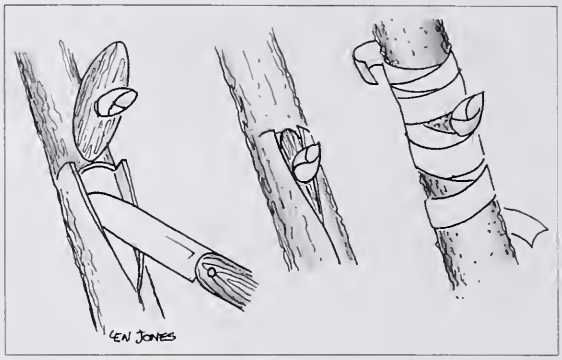
The following genera are all capable of producing new plantlets from the leaf bases: *Streptocarpus*, African violet (*Saintpaulia*), *Sansevieria*, *Gasteria*, *Haworthia*, *Crassula*, and *Kalanchoe*

Southern African Begonias tend to have tuberous rootstocks and they root better from normal cuttings. Mesems, including *Lithops* and *Conophytum* will all divide from leaves if they are carefully separated from the parent plant. *Euphorbia* will grow from stems that resemble leaves. Dry out the cut stem for at least a week before striking it in a cutting bed.

Budding, grafting, and layering

These three forms of vegetative propagation are not as popular in southern Africa as in the temperate parts of the northern hemisphere. In commercial horticulture, budding and grafting are used in the production of citrus and nut plantations where superior fruiting varieties or clones are budded or grafted onto tough rootstocks that will support the better cultivars.

There has been a certain amount of grafting work done on the genus *Adenium*, but in Africa, it is far simpler and quicker to grow these plants from seed.



▲ *Budding. (Drawing: Len Jones.)*

Budding

I have included one method of budding only—the T-bud method is most commonly used for citrus in this country. Bud-wood of specific varieties is shipped to a grower and the buds are removed from the bud wood twigs. These are inserted into the rootstock or scion citrus, usually a very vigorous species that does not produce good fruit. A T-shaped cut is made on the stem of the rootstock and the young bark is pulled away to form a pocket or flap into which the bud is inserted. The stem and bud areas are wrapped tightly with budding tape to seal the wound, prevent drying out, and keep pathogens from entering. It takes about 4–6 weeks for the wound to heal. The young bud will have calloused and fused its cambium with that of the scion. The bud is left exposed to grow.

▼ **main photo** *Young rootstock seedlings being grown on in an insect-proof shade house to prevent insect vectors spreading virus pathogens to the rootstocks;* **inset** *Young grafted plants with new shoots of the preferred variety of citrus on tough rootstocks. The main shoot visible here is still that of the rootstock and will be removed once the buds have grown a little larger.*

The T-bud Method

1. Remove the bud from the scion.
2. Now cut a T-shape into the rootstock stem. Lift bark and cambium carefully with the sharp budding knife.
3. Insert the bud into the T-cut by sliding it between the stem and lifted bark.
4. Bind the bud tightly with the tape.
5. Once tightly bound with budding tape, leave the bud to form a union with the rootstock. It can take weeks or even months.
6. A bud that has "taken" and has been untied. This bud will now shoot to produce the new shoot of the preferred cultivar.
7. A shooting bud. Once this bud is strong enough, the upper section of the rootstock shoot is removed so that all the energy goes into the new bud growth.

Grafting

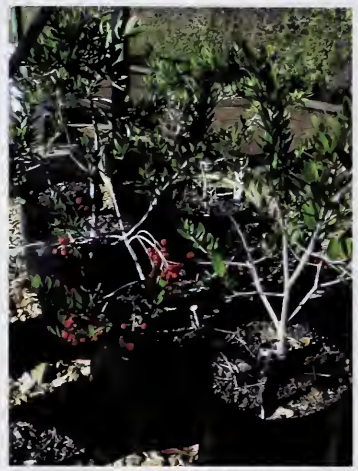
I mention two kinds of grafting—the saddle graft and the whip graft. These are most successful when you use a twig with the diameter of a pencil, or a little thicker (up to about 10 mm). The thickness is important to ensure that the stem is quite firm and still in active growth. If woody bark has already been set down, fusing the cambium layers may be less successful.

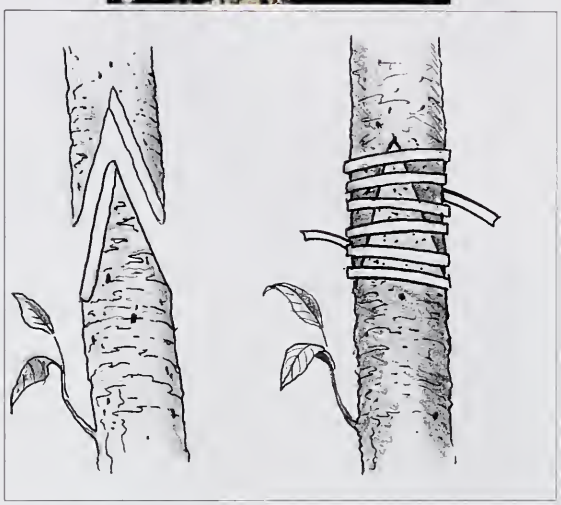
Saddle grafting

I have used the saddle graft method for *Adenium*, *Pachypodium*, and members of the *Solanum* genus. This method entails making two slanting cuts on either side of the rootstock to form a wedge shape. For the scion, a notch is cut in a similar-sized piece of stem to ensure that the two sides of cambium layers match each other when the two shapes are slipped over each other. It is important that the piece is cut from the previous year's growth. Once the two stems have been joined, the join is wrapped tightly with plastic budding tape, which has replaced raffia. Once the new growth appears on the scion, the budding tape can be removed by simply cutting it off with a sharp knife or scalpel.

Whip grafting

The whip graft entails making a slanting cut right through a thin branch or twig on the rootstock, as close to the ground as is comfortable working, about 50–100 mm. A similar angled cut is made on the scion. The two cuts are matched together and bound with budding tape. If the branches are not the same diameter, cambiums of the two sides are matched up and bound together with budding tape.





▲ **top** Olinia emarginata *plants propagated at Kirstenbosch using air layering;* **bottom left** *Saddle graft preparation. Cut a notch in the scion and a wedge in the rootstock;* **bottom right** *The two pieces are slipped over each other and tightly bound with plastic budding tape. (Drawings: Len Jones.)*

Layering

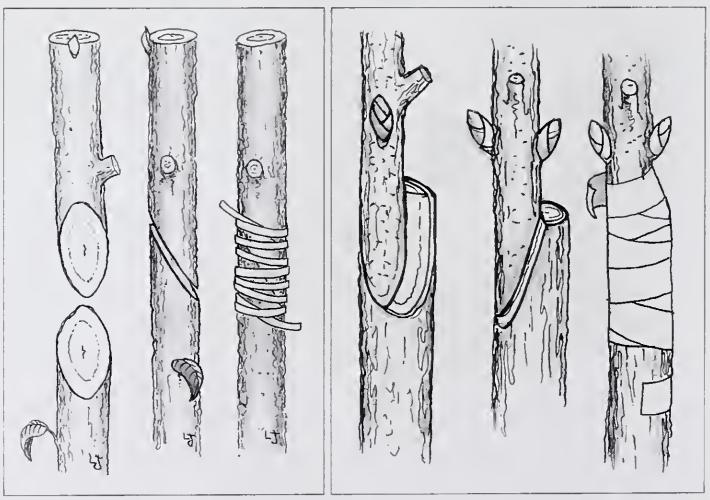
Air (or aerial) and ground layering are the main forms of layering. Many of our plants respond best to these methods of vegetative propagation. It must be stressed that layering is a last resort if there are only a few specimens of the plant that you want to propagate. It is not a very efficient way to bulk up quantities of plants.

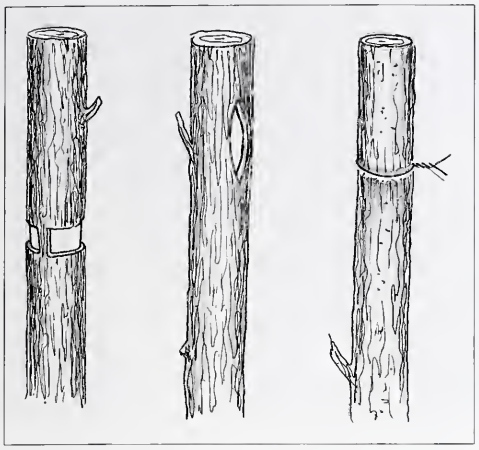
Air layering

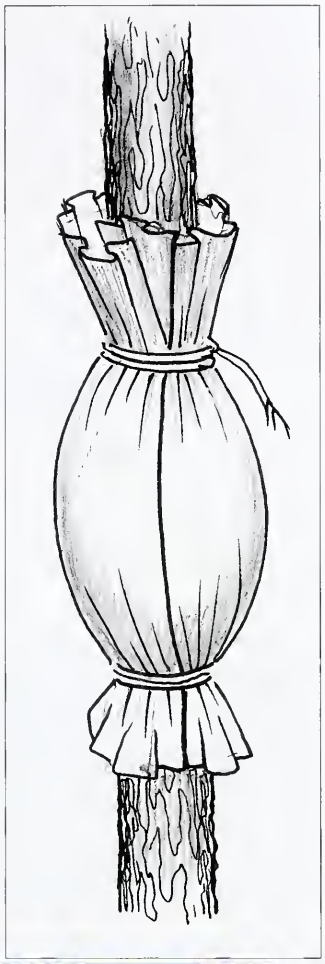
Air layering is a good method to establish plants that are large or difficult to root, for example, figs. At the Kirstenbosch National Botanical Garden, I have seen *Olinia emarginata* grown successfully using this method.

1. Partially ring-bark a section of the selected branch by about 90%.
2. Apply a bit of rooting hormone to the ring-barked section. Encase the cut area with vermiculite and a little rough sand.
3. Dampen the vermiculite mixture to encourage root formation and prevent desiccation of the cut surface.
4. Cover this with a long black plastic planting tube with the end cut off.
5. Tie off both ends of the plastic.

▼ **left** *Whip graft used for stems of equal size;* **right** *Whip graft showing the method for joining stems of unequal size. (Drawings: Len Jones.)*







▲ **left** *Air layering showing different methods of damaging stem to encourage root formation;* **right** *Air layering showing filling of sleeve. (Drawings: Len Jones.)*
▶ *Air layering filled and tied at both ends of sleeve. (Drawing: Len Jones.)*

6. After about 6 weeks, untie one end of the plastic sheath and inspect to see if any roots have formed.
7. Once there are more roots visible than the vermiculite rooting mixture, it is time to sever the branch from the parent tree.
8. Once severed, put the new plant into *intensive care* for a few weeks to enable the new roots to establish, so that they can start feeding the plant. Intensive care means that you place the plant in a shady, sheltered area—a mistbed is best suited to convalesce the plant until it starts sending out new shoots. Water and feed regularly.

▲ *Air layer of* Ficus verruculosa.

◀ *Air layer of* Ficus verruculosa, *showing the roots that have developed in the palm fibre and sand mixture. Clear plastic was used to demonstrate this method of propagation. Normally black plastic sleeves are used.*

Ground layering

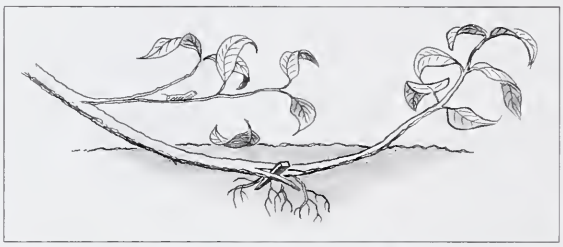
Ground layering is associated with plants like Azaleas and Rhododendrons, as well as creepers, for example, the Bignonia family's *Podranea ricasoliana* and *P. brucei.*

1. Make a slanting cut on the lower side of a branch that is nearly touching the soil, or bring the soil to the branch by placing a tray or container under the branch at the required height.

▲ *Ground layering showing cut and soil around cut. (Drawing: Len Jones.)*

Use a little rooting hormone on the cut and peg the branch with its cut onto the soil.

2. Ensure that the branch stays immobile in the soil to prevent the delicate roots from breaking as they form. Depending on the time of year and the species, the process of rooting may take weeks or many months.



▲ *Ground layering showing roots forming at cut. (Drawing: Len Jones.)*

Rhizomes

Some plants have rhizomes—distinctive, horizontal, underground side stems—which can be broken or cut up to produce new plants. These include *Dietes* species, *Impatiens shirensis*, *Siphonochilus aethiopicus*, certain *Kniphofia* species, such as *K. pauciflora*, *Sansevieria*, certain mat-forming grasses, and ferns such as *Microsorium*, *Nephrolepis,* and *Rumohra.*

- Let the stem dry out for a day or two to help seal the cut. Flowers of sulphur can be used to coat the cut to prevent fungi or other pathogens from attacking it. Ferns, however, need to be kept damp.
- Use a piece of stem that is at least four or five nodes in length. This provides the rhizome with some stored energy to enable the generation of a new set of roots and shoots.

Many water, bog, or marsh-loving plants produce stems that can be cut into pieces, each of which will grow to produce a new plant. Examples of such plants include *Mentha longifolia*, *Mentha aquatica*, and *Gunnera perpense.*

- Trim back the shoot by at least half to prevent too much strain on the new roots.
- Split the plant at the beginning of the growing season, just before the new growth starts.

Rubus rosifolius sends out suckers that travel metres from the parent plant and pop up to produce a new stem. To propagate this species, loosen the soil around the new suckers and lift the new plant out into its new container.

Ferns

Koos Roux from Kirstenbosch wrote that the structure of the rhizome in most fern species allows them to be propagated through division.

- Simply lift the rhizome and divide it into suitable, not too small sections.
- Keep the fern stems damp at all times.
- Always ensure that the rhizome tips remain intact. Smaller species with thin, unmanageable rhizomes grown in pots can simply be removed and halved.

Tubers

Tubers can be used to propagate the tuberous Begonias, including *Impatiens*, for example, *I. flanaganae*, *I. tinctoria*, *I. hydrogetonoides*, and *I. quisqualis,* and *B. sutherlandii.* The tubers can be split while these plants rest during the dry season.

- Use a sharp knife to divide the crown growth so that there is a growth point on each tuber from which the new shoots can develop.
- Treat the wound with flowers of sulphur or a fungicide to prevent infection.

▲ *Tuber of* Impatiens flanaganae.

Roots

I have made some interesting observations regarding root propagation over the years by watching what road builders do to plants. After a road cutting has been made through a landscape, damaged plants begin to heal themselves, even in cases where a road grader or pay loader simply cuts a vertical bank and pushes the soil out to create a cut and fill platform. *Acacia* trees regrow from roots, as do *Warburgia salutaris*, *Dalbergia obovata*, *Ehretia rigida*, *Rhus pentheri*, *Rhus chirindensis*, and *Rhus macowanii*. *Jasminum* species also shoot or regrow from root cuttings.

▲ *A hedge of* Warburgia salutaris *at Kirstenbosch used for cuttings.*

Spring to early summer is generally the best time to take cuttings if your seasons are well-defined. For the countries north of South Africa, where there are also dry and rainy seasons, but where temperatures stay constant, cuttings should be taken at the beginning of the normal growing season. These countries include Angola, Malawi, northern Mozambique, and Zambia.

- Take root cuttings when the plant is beginning to enter its new growth cycle and the sap of the plant that you want to propagate is rising.
- Cut off roots that are about 150 mm long with a diameter similar to that of a finger.
- Lay these horizontally in a mistbed or in a tray of sharp river sand and more or less bury each root to its own depth in the medium. Keep damp and wait.

In the past, there was only one cultivated plant of the Breadfruit Tree (*Artocarpus altilis*) in Durban. We wanted to produce more plants, but cuttings never rooted. I happened to see an old friend from the Seychelles who suggested that we attempt propagation from root cuttings. He used this method to grow breadfruit trees on the islands and to find better-fruited varieties that would grow, true to form, if he used vegetative means. We followed his advice and within a few weeks, there were new plants for the Botanical Gardens.

In general, seed is really the best way to propagate bulbous plants in large numbers, as most species produce large quantities of seed. Furthermore, seedlings adapt to their surroundings immediately, provided they are sown at the correct time of year. Bulbs, on the other hand, take much longer to acclimatise when removed from different climatic zones. Seeds of bulbous plants that are indigenous to winter rainfall areas (like the Western Cape), are sown in autumn and those from summer rainfall areas (like KwaZulu-Natal) are sown in spring.

Certain bulbs like Cyrtanthus labiatus *and* Watsonia meriana *cv. Bulbillifera increase by bulbil formation, but these bulbils are relatively slow in growing. Other species like* Scilla natalensis, Eucomis autumnalis, Scadoxus puniceus, *and* Cyrtanthus mackenii *will produce offsets from the mother bulb, which will develop into independent plants quickly if split from the parent during the dormant season. This is preferable in late winter for the summer growers and in late summer for the winter growers. The rule is to try finding some good roots with the new offset.*

—Graham Duncan, Kirstenbosch

◀ Watsonia meriana *cv. Bulbillifera.*

▼ Cyrtanthus labiatus *bulbils.*

Bulbs and corms

Watering

As plants have individual watering needs in the wild, their needs also differ under cultivation. This implies that the timing of water application is often critical. Watering bulbs is one of the most important, time-consuming, and intricate operations, because in a big collection there are both summer and winter-growing species. Furthermore, there are species that, although belonging to a single genus, originate from very different areas. Watering therefore has to take place on a species-by-species basis.

Weeding and pest control

Weeding is another problem. Many bulbs are invasive species, making the hard work required to ensure that they do not swamp other species in close proximity a seasonal chore.

Checking for the lily borer or Amaryllis caterpillar is also a daily chore in South Africa, and concerns larger outdoor collections. Screened growing houses prevent this pest, but aphids, mealy bug, thrips, and scale all manage to get into collections. High densities of similar plant types make it easy for the insect pests and other pathogens to invade a collection. Again, vigilance is the key word.

Graham says that because cross-pollination from bees causes hybrids, it is advisable to screen the growing house, particularly in the case of a collection of rare species, to keep the bees and other pollinators out of the enclosure. However, the downside to this is that one has to pollinate most of the bulbs by hand, other than the Amaryllids, which are generally self-fertile.

Plant propagation is a slow, unrelenting process. Watching a person like Graham in his collection is enlightening. As he walks between the rows of pots or beds, he is constantly feeling the soil to see if it is dry or wet, or the bulb to ascertain if the bulb is firm in the pot (meaning it is healthy), checking that the roots are intact, and removing weeds.

TIP

It is important to monitor the beds daily and check the area thoroughly for any signs of disease. When growing many different plants, identify and monitor the individual species or plants in terms of water needs. Blanket watering is a recipe for disaster.

Tissue culture

Tissue culture and seedbank methodologies require complicated technology, and both these approaches to plant propagation are covered in other texts. It.

If curators feel they are able to do tissue culture, they could contact Kirstenbosch, the University of Natal (Pietermaritzburg Campus), or the Durban Parks Department. These are all institutions that will happily assist where they can. However, given budget constraints and the tendency to outsource certain functions, these institutions will require payment for the work associated with producing plants in this fashion.

Aloe polyphylla and *Siphonochilus aethiopicus,* two endangered species, have been propagated relatively easily by the Research Centre for Plant Growth and Development, School of Botany and Zoology at the University of Natal, Pietermaritzburg, and the National Botanical Institute at Kirstenbosch.

▲ *Tissue-cultured plants of* Aloe polyphylla *in the nursery.*

Using rooting hormones

The most easily obtained rooting hormones are Seradix 1, 2 and 3. Speed is essential to ensure good cuttings. Do not dry the cuttings out, so work in a humid atmosphere.

- Plunge the prepared cuttings into a bucket of water and take them out only once all preparation has been done for setting them in the cutting bed or tray.
- Dip the cut end of the cutting into the powder.
- Tap off the excess powder from the cut end.
- Make a hole in the rooting medium for the cutting, using a dibber or nail.
- Place the cutting in the hole and tamp the medium back up against the stem of the cutting with the dibber.
- Water the cuttings once a batch of 50–100 cuttings is done. This helps to seal the cut end and ensures that an air lock is not created.

Tissue culture of medicinal plants

The Durban Parks Department has 21 species of medicinal plants in culture:

Albuca nelsonii
Albuca setosa
Alepidea amatymbica
Aloe aristata
Ansellia africana
Bowiea volubilis
Dioscorea dregeana
Dioscorea sylvatica
Drimiopsis maculata
Eucomis autumnalis
Eulophia speciosa
Gasteria croucheri
Gloriosa superba
Haemanthus albiflos
Haworthia limifolia
Hypoxis hemerocallidea
Polystachya zuluensis
Schizobasis intricata
Scilla natalensis
Siphonochilus aethiopicus

Remember that most of these species can be grown from seed and it is a lot cheaper and quicker to produce them than by tissue culture. Nevertheless, the tissue culture protocols are done and in place if we ever need to bulk up the numbers of these plants.■

▲ **left** *Growing shelves in the Durban Parks Department tissue culture laboratory;* **right** Alepidea amatymbica *leaf pattern.*

▲ **top left** *Albuca setosa;* **top right** Aloe aristata *in cultivation;* **bottom left** Siphonochilus aethiopicus *in cultivation in Durban;* **bottom right** Gasteria croucheri *at Bridgevale Municipal Parks Department Nursery, Durban.*

Chapter 4

Guidelines for collecting plant material

WHEN IN THE FIELD ON A COLLECTING TRIP, BE METICULOUS to observe the habitat that you are collecting in. At microhabitat level, establish whether the plants grow in deep shade, or are exposed to full sun, whether they grow in well-drained soil or not, and whether they grow in leaf litter or between rocks. Take rocks and stones from the original habitat, as well as some soil to inoculate the growing medium. Rather than removing the parent plant from its natural habitat, collect seed or cuttings.

Preparing for a field trip

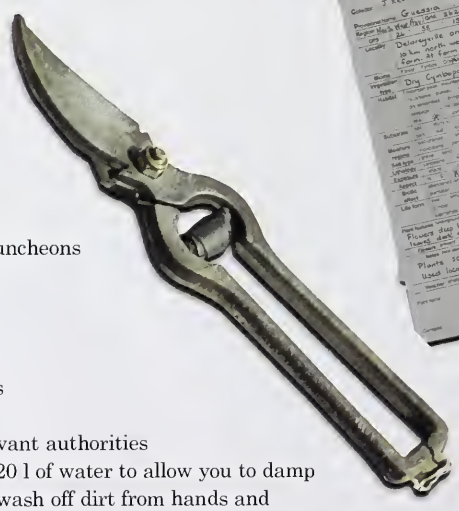
When collecting plant material in the field, you'll need to plan. It is very frustrating when you're far from home and find out you've forgotten something essential. Record keeping is vital; it takes time and energy, but it is worth it in a year's time when you want to see where and when you collected a certain plant. Human memory is a very variable thing! Pressing—and mounting—voucher specimens is another way of keeping a record of the plants you have collected.

I re-use 50 kg fertiliser bags instead of heavy-duty bags; the plastic is clear, tough, and costs nothing. Take some string along to tie the bags or the specimens into bunches with their attendant collecting labels. I always use a label that can be written on with a 2B grade pencil; it works in the dry and the wet. You'll also need digging tools to collect soil samples or to remove plants.

If you're serious about field collecting, I recommend the book *Herbarium Essentials—the southern African herbarium user manual* (Victor *et al.*, 2004).

Equipment

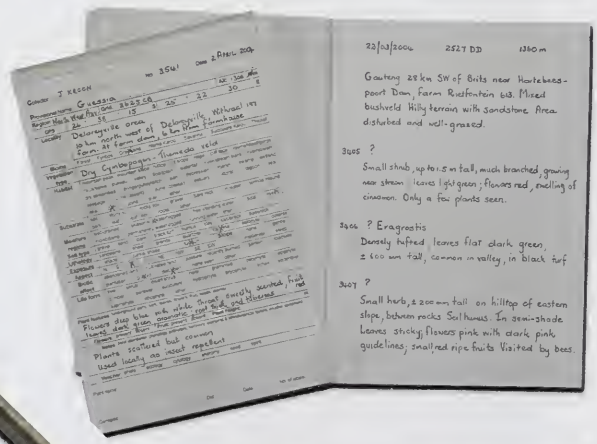
- Notebooks
- Pencils
- Labels
- Camera
- GPS (if you're lucky)
- Secateurs
- Sharp knife
- Bow saw for larger truncheons
- Spade
- Large garden fork
- Crowbar
- Large plastic bags
- Zip lock bags for seeds
- String
- Permits from the relevant authorities
- Water—take at least 20 l of water to allow you to damp down cuttings and to wash off dirt from hands and plant material



Sampling

Stratified random sampling is the best method to use. Before sampling, the habitat is divided into different patches (contrasts in aspect, slope, soil, vegetation density, moisture, areas of previous disturbance, etc.). Individual plants are then randomly chosen from each patch. Samples are allocated in proportion to the size of the patches. If the habitat is uniform, random sampling is best. If a supplementary biased sample is needed (unique individuals), this sample should be kept separate.

- To preserve the maximum amount of genetic variability, there should be sampling at the extremes of a species' range in addition to the central parts.
- A general rule is to sample 10–50 individuals per population.
- For species occurring in three or fewer locations, all populations should be sampled.
- Among more widespread species, three to five populations should be sampled.
- Where there are large numbers of populations within a small area (and the boundaries between different populations may be blurred), it is better to treat these as a cluster. Sample one or two populations per cluster, and five clusters altogether. For two, three, or four clusters, one would sample two or three populations per cluster.



Seeds

Although plant selection is the key for passing on good genes, seed collected from as diverse a group of plants as possible, that is, different plants of the same species, is a very important principle to ensure genetic diversity and plant production.

Regard the following as general practice when collecting seed:

- Gather the best looking and largest fruited forms of the plant you want to grow and discard the shrivelled and malformed seed.
- Label the better forms of a species that are to be kept as future seed-bearers.
- Collect seed from 10–50 individuals.
- Equal numbers of seed per individual should be sampled to avoid unwanted bias.
- Sample size must allow for poor germination potential.
- Maximize the diversity within the sample by collecting as many fruit as possible from different microhabitats and at different times, to increase the number of pollination events and pollen sources.
- The collector cannot be sure of the exact number of parents (for out-breeding species); therefore, it is better to collect more.
- When only seeds are collected, multi-targeted trips should be organised, because species differ in maturity date.

Cuttings

Cuttings can be harvested at most times of the year, although the time of harvest affects the strike rate. They require speedy processing to retain their viability and need ready availability of space and proven techniques. Woody or perennial species are easier to process than annual herbaceous species; the latter require culture by *in vitro* methods.

Fewer samples are needed with cuttings compared to seeds, because the collector can be sure that an explicit number of distinct, naturally occurring individuals have been sampled.

- Sample 10 individuals from varying microhabitats, or randomly.
- Include any morphological variant likely to be both genetically based and of definite interest.
- Sample size must allow for poor striking from cuttings.

TIP

Cover your thumb with a piece of plaster to prevent being cut.

- The size of a cutting is important in propagation and depends on the family.
- For cuttings of any delicate plant, use a sharp pruning or budding knife. The last thing one wants is a cutting with a bruised stem kept for weeks in cutting medium under warm, moist conditions. This is a good recipe for pathogens to attack and kill the fledgling plant.

WARNING

Do not use secateurs, because the blade that moves up against the anvil will bruise the stems.

- Collect cuttings with straight stems for a better plant shape.
- Keep the cuttings damp and cool by using clear plastic bags and not black bags. The dark bags absorb heat and will parboil the cuttings.
- Place them in a shady spot when taking a rest. If it is necessary to leave cuttings in the bags for longer than a day, do not expose them to sunlight.
- Provide an anti-stress drench. This is a way to prolong life out of the soil for delicate plants: plunge these plants and broad-leaved species into clean water, for instance, a mountain stream, each evening to revitalise them. Some people dip the cuttings into a solution of seaweed extract, Vitamin B12, or sugar/sucrose. Some use homeopathic remedies.
- A cooler box protects cuttings from extreme changes in temperature on field trips.
- Zip lock bags seal in moisture.

Seedlings

Another form of propagation or collection, also known as "wildings", refers to wild-germinated seedlings, often found under the parent tree or plant.

It is possible to lift seedlings from the forest floor or other natural habitat. This method works well in the case of trees and shrubs.

- Use a garden fork to loosen the soil around the plant and gently lift the plant without damaging its roots.
- Place the plant in a sealed plastic bag to prevent the roots from drying out or pot it up into appropriate planting tubes or black bags.
- Leave the lifted plants in the shade for about a week before gradually shifting them into their final growing light intensity.

I would collect as wide a variety of seedlings from under as many parent plants as possible to improve genetic variability.

Whole plants

Collecting cuttings and seeds are probably the better options than collecting whole plants, unless germination techniques are not known or viable cuttings cannot be taken.

There are two disadvantages to collecting whole plants:

- Removing whole plants can destroy a whole population. It is inappropriate for a rare and endangered species, unless the destruction of the natural source population is certain.
- Transplanting whole individuals of deep-rooted perennials is difficult. Transplants of whole individuals require handling as large cuttings.

Information in this chapter was collected from Bennett (1970), Brown & Briggs (1991), Falk *et al.* (1996), Ford-Lloyd & Jackson (1986), and the Centre for Plant Conservation (1991).

Chapter 5

Plants with special needs

Some groups of plants have special requirements for successful propagation and cultivation. I discuss the following groups here:

- *Aquatic plants*
- *Cycads*
- *Carnivorous plants*
- *Fynbos plants*
- *Parasitic plants*
- *Succulents*

Aquatic plants

It is relatively easy to maintain aquatic plants under cultivation.

Construct a series of leak-proof ponds, each fitted with a drainage plug to make it easy to clean when necessary. Drainage plugs are also useful because they allow varying water levels in individual ponds, according to the seasonal needs of the plants. Build the pond with an incline. The deepest area should measure about 400 mm. The slope creates a ramp for frogs and young plants.

Fill the pond to about a third of its depth with river sand and plant the collected specimens. Some plants may prefer a clay substrate, but I have found that most plants just need a root anchor. The size of the pond is not that important, but keep in mind that five mature plants of a species should be able to grow in a tank. Allow the plants to produce seed that can be left to mature in the pond—these will eventually settle at the bottom of the pond and germinate when the time is right.

Different levels and depths allow for germination experimentation. Observation is the key to successful cultivation of these plants, given the lack of knowledge about the subject. In nature, plants grow in pans and ephemeral pools that allow for seasonal drying. A drainage plug in the growing tanks is a useful way to imitate the seasonal drying needs of the plants. Many species of

▶ **opposite** Crinum campanulatum *plants growing in a vlei just south of East London.*
▼ Potamogeton pectinatus *cf. A species of rivers and pans.*

Crinum like to have a dry period of up to six months, even though they grow and flower in water. The drying out of seed may also be a way of breaking dormancy.

Many species of *Potamogeton* and *Aponogeton* divide and form mats of plants. *Potamogeton* seeds are loosely attached and float off. These grow in 100 mm deep water.

Nymphaea nouchali, Aponogeton junceus, Ottelia exserta, and *Monochoria africana* all need shallow water in the beginning of the growing season, which deepens as the rainy season progresses and again becomes shallower as the dry season approaches. The seeds of these species germinate near the parent plants if the pond is left undisturbed. However, a period of dormancy or drying out may be required to maintain species like *Monochoria.*

The famous *Aponogeton ranunculiflorus* of the Drakensberg summit grows at about 2,400–3,300 m in rock pools on the tops of mountains and requires these kinds of conditions to thrive.

Many water plants are able to propagate themselves by vegetative means very easily. Under cultivation, one can split or break off pieces of the plant. For the unattached aquatics, leave the pieces to float. For attached aquatics, bury about a third of the length of the broken off piece into the substrate where it will root again and grow a new plant. Species like *Vallisneria aethiopica* and *V. spiralis* send out runners that can be broken off and rooted in a new pond.

Cycads

Propagation from seed

Cycads can be propagated from seed. Male and female cycad cones are borne on separate plants. To produce fertile seed from cultivated cycads, it is necessary to hand-pollinate the female cones. The only way to tell a male plant from a female plant is by comparing their cones; the male cone is usually long and slender with small cone scales while the female cone is egg-shaped with large cone scales.

Collecting pollen

Just before pollen is shed, the male cone starts lengthening. This is easily noticed as the tightly packed scales start separating. Pollen starts being shed once the central axis is fully extended. Remove the cone from the plant at this stage by covering it with a plastic bag and cutting it off at the base. Place it on a piece of smooth paper in a draught-free room. After a few days, all the pollen will have been shed and it can be used immediately for pollination or stored for later use.

Before storing, pass the pollen through a fine sieve to remove all impurities and place in a sterilized jar. The lid should be sealed to prevent moisture reaching the pollen. A sachet of silica gel placed in the jar will absorb any excess moisture. Store the pollen in jars in a deep freeze. This pollen can be used successfully for a year or two.

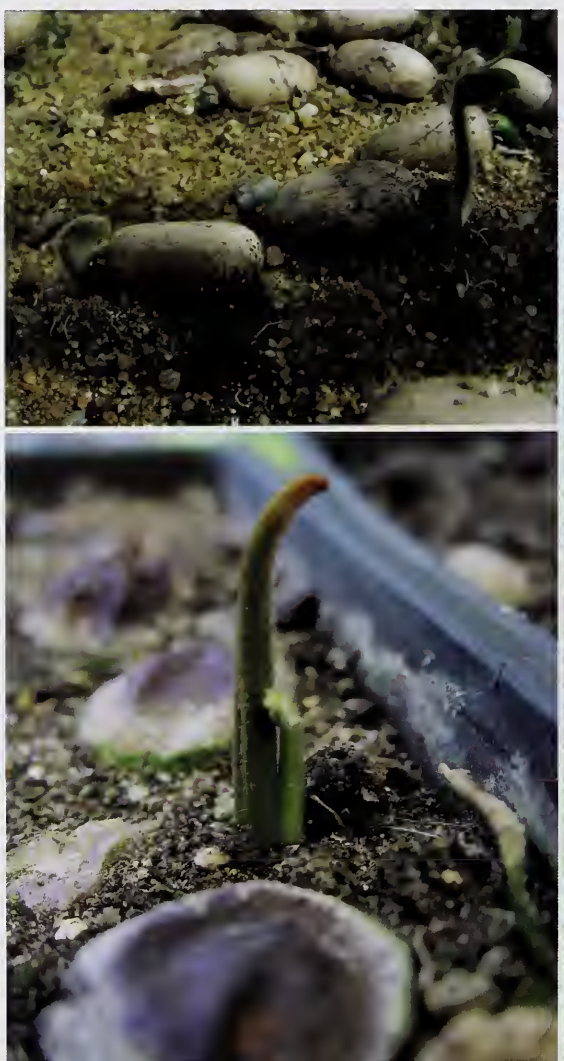
Pollinating the female cone

When the female cone is mature, scales on the top half of the cone separate slightly and move about 2–3 mm away from one another, and it is assumed that the female cone is now receptive. Despite these changes, it is often difficult to know when cones of some species are receptive. If there are male cones in the vicinity, natural pollination may occur. However, to ensure good seed set and to avoid hybridization, it is better to collect pollen and to artificially pollinate female cones. There are various methods of artificial pollination. For the best results, pollinate the female cone as many times as is possible, regardless of method, using one teaspoonful of pollen each time.

Method 1. Using a teaspoon, disc, or spatula, place the pollen in or in front of the openings between the scales of the cone. Use a small spray or syringe to blow the pollen into the cone at all of the visible openings. This process should be repeated daily until the spaces between the scales close. Alternatively, remove the uppermost scales using a sharp knife and inject the pollen into the spaces next to the cone axis. An infant enema bulb (available at chemists) is ideal for this purpose. After pollination, replace the "cap" of scales on top of the cone.

Method 2. Take one teaspoonful of pollen and mix it with 200 ml distilled water. Pour the mixture into

▼ **top** Encephalartos ferox *seedling;* **bottom** Cycas circinalis *seedling;* **opposite** *Cycads growing in Kirstenbosch National Botanical Garden.*



the openings between the scales. Alternatively, squirt the solution into the openings using a syringe with a narrow ridged tube attached. Repeat daily until the openings between the scales close.

Method 3. Place a plastic bag over the female cone. Using a plastic syringe, puncture the bag at the top and blow the pollen into the bag with the syringe. Remove the bag after 15 minutes and repeat the process daily until the openings between the scales close.

Harvesting and storing seed

It is believed that the flesh covering cycad seed contains carcinogens and precautions should be taken when harvesting and cleaning seed. Handle seeds in a well-ventilated room or outdoors, and wear a face mask and gloves. When mature, the female cone begins to disintegrate and the entire cone should be removed form the plant. Immerse the seeds in water for a few days to soften the flesh. Rinse seed in clean water to ensure that all flesh is removed before treating with a fungicide (for example, Benlate or Kaptan). Once dry, store the seeds in brown paper bags in a cool dry place.

Sowing and germination

After harvesting, cycad seed should not be sown immediately, but stored for a period of at least six months. From the time of fertilization, the ovule develops continuously and even when the seed has been harvested, the ovule continues to develop. The seed is ready to germinate after six to nine months, when the embryo is fully developed. To germinate, cycad seeds require moisture, warmth, humidity, plenty of oxygen, and a clean, healthy environment.

Bottom heat (28°C) stimulates germination; cycad seed will germinate at lower temperatures, but the process will be slower. Regular watering helps to maintain relatively high humidity levels and a well-aerated propagation medium containing coarse particles provides good aeration and drainage. Fungi and bacteria can destroy cycad seeds, so as a precaution before sowing, treat the seed with a fungicide solution like Kaptan. Do the flotation test and discard all floating seeds. These floating seeds indicate that the embryo has not developed and they are infertile.

The conventional method of sowing is to place the seeds in rows lying horizontally next to one another on the propagation bed or in containers. The seed is pressed

down level with the surface of the propagation medium. It is important to label the seed with the name and the date of sowing, in order to be able to track the young plants in the future.

The propagation bed should be 200 mm deep to allow sufficient depth for root development of the seedling. Germination can take place within a month or longer, with the root appearing first. Once the first leaf has developed, the young seedling can be planted in a 2 l black plastic planting bag and placed in light shade in the nursery.

Carnivorous plants

The simplest way of growing carnivorous plants is on a sunny, north-facing windowsill. These plants tend to need humid conditions—place the pots in a tray of water. Enclose the whole growing area to increase humidity further. A terrarium works well to keep the moisture in. Larger collections should be grown in a glasshouse where a climatic control system is in place.

Clay pots are ideal for growing carnivorous plants. Where this is not possible, use plastic pots with a 100 mm diameter. Square-sectioned pots are better, as these pack easier and fit better into the trays of water. Different species need to be immersed at different levels in the water.

For *Drosera*, place the pot in the water at a depth of 20 mm during the growing season. During the dormant season, keep the growing medium damp or moist, but not wet, allowing the plants to rest. In a winter rainfall area, place the pots in water during winter and spring, and dry them out during summer. Water or wash the leaves in the early morning to allow enough time for the crown to dry before evening. Do not wet the crowns of the plants in the evening, as they will not dry out. This allows any fungal spores a better chance of germinating and attacking the plant, especially if there is a large drop in air temperature. Keep the water temperature and ambient air temperature as close to each other as possible.

Terrestrial Bladderworts, such as *Utricularia prehensilis*, *U. livida*, and *U. sandersonii* live in marshy wetlands or along cracks in the rocks on the edges of running water or near the edges of ponds in relatively shallow water. They prefer to grow in shallow pans or trays, immersed in about 25 mm in water.

The aquatic species, such as *Utricularia benjaminiana*, *U. inflexa*, and *Genlisea hispidula* need to be grown in aquariums. To ensure reasonably acidic conditions, immerse peat or sphagnum moss in the water with the plants. Keep in mind that these carnivorous plants want living food—inoculate the water with some of the water from the dam or pond where these plants were collected. Do not use chlorinated water to top up the aquarium as this kills off the plants and their prey. Water fleas of the genus *Daphnia* are minute crustaceans in the order Cladocera and are the best food for these plants.

It is best not to feed these plants, but to let them obtain their nutrients from their prey. If you do not have enough insects or water fleas, a dilute quarter strength foliar spray every two weeks in the growing season should be fine. Do not be tempted to overfeed the plants.

WARNING

Never use insecticides on these plants, as this will kill off the insects that provide the protein for them.

Scrupulous hygiene is necessary to keep away fungi. Any dead leaves and other plant debris must be removed. Good ventilation and air movement assist with fungus control. Only resort to fungicides when all else fails. Full sun is also important to help reduce attack from other pathogens. As in the case of succulents, a quarantine area, away from the main collection, is useful when treating diseased plants.

Carnivorous plants need perfect growing conditions and attention to detail. Therefore, unless you are really dedicated and passionate about these plants, do not attempt to grow them. because they will invariably die.

Propagation

All of these plants can be propagated by division in the active growing season. Seed also germinates well if collected and sown on the same growing medium. Root cuttings of the *Drosera* species work well as a method of propagation, as long as fungi do not attack the cut ends of their thick, fleshy roots. Lay the roots on the surface of the growing medium or on a bed of sphagnum moss.

▶ Utricularia gibba *is a species that grows on the edges of pans on the eastern seaboard of southern Africa. It uses its tiny bladders to capture minute pond fauna.*

Fynbos plants

For details on propagation from seed, see the section on Fynbos seed in Chapter 2.

For those of you who live in countries situated more north, such as Malawi and Zambia, I suggest you apply the same propagation principles used to propagate the southern fynbos species. This will include the high altitude endemic Proteas and Ericas, as well as some of the other shrubby species that inhabit these high-rainfall, low-nutrient areas.

Anthony Hitchcock, nursery manager at Kirstenbosch, stresses the importance of observing plants in the wild, especially plants from the Fynbos Biome. The main species in this biome are Proteas, Ericas, Restios, and geophytes (bulbs).

▲ Erica cameronii *in cultivation at Kirstenbosch.*

Buchus

Heel cuttings work best for Rutaceae. Keep in mind that the Buchu family has tree representatives in the southern Cape Province and summer rainfall areas. Normal rooting time for fresh, semi-hardwood cuttings is 6–10 weeks. Hardwood cuttings take 3–4 months to root or for callus to develop. The re-treatment with rooting hormone normally shows results after two months. The recommended length for Buchu cuttings is 2–4 cm.

For details, see Rutaceae in Chapter 6.

Ericas and Restios

Ericas and Restios like the same types of soil. Although both will tolerate more feeding, overfeeding is not advisable (especially with nitrogen and phosphates). Overfeeding Ericas, for instance, will result in large, unnaturally overgrown, soft-leaved plants that will not survive for long.

Take cuttings on the shady side of the plant or from inside the plant. Do not take cuttings from old growth, but rather from new, same-season growth. The recommended length for *Erica* cuttings is 2–4 cm. It is preferable to use heel cuttings with fine, thin stems in the case of Ericas. Another option is tip cuttings, provided they are taken off the side branches.

Proteas

Proteas grow in unique circumstances, that is, in sands that have a high organic matter content, with a low nutrient status. Under cultivation, the *Protea* should do well in the types of soil found in the wild that are usually sandy, acid, drain well, and have a high humic content.

For the Proteaceae, tip cuttings are best, although heel cuttings also work.

Take cuttings of Proteas and Pincushions in early summer, rather than late summer, when there is fresh growth after flowering. This is important, because the

◀ Erica cameronii *cutting selection.*
▼ **left** *This is the ideal size and length of an* Erica *cutting, giving just enough woody strength of the stem for roots to develop;* **middle** Serruria *cutting;* **right** *Algae attacking* Serruria *cuttings.*

▲ *Top Crop seedling house temperature is kept at a constant 30°C.*
▶ **top** Leucospermum *cutting rooted in a fibre bag;* **bottom** *A whole batch of rooted* Leucospermum *in a deep tray that keeps the plants together during transportation.*

flower buds have already initiated at the end of summer, ready to produce flowers during winter and spring. This is a winter rainfall phenomenon.

The best size of these cuttings could range between the thickness of a pencil and your little finger. Apply a rooting hormone if possible. The cuttings will take long to root and must be watered once a day.

Lay the cuttings in mistbeds with bottom heating. A harder, more mature cutting is best if only a cold frame or shade house with no mistbeds is available.

Propagation

Propagation from thin, hard stems may cause a callus to form, but not roots. Remove the cuttings and damage the callus slightly; re-apply rooting hormone and replace the cutting in a clean rooting medium. In most cases the cuttings root freely soon after.

Apply an organic fertiliser, low in nitrogen and phosphates in particular, on a regular basis, to produce a good balance of growth between the leaves and the roots. Without fertiliser, the plant will suffer and even expire under conditions marked by temperature extremes during a hot, dry spell.

The roots must be able to support the shoots to ensure survival when planted out in a botanical garden. One has to treat the plants a little "roughly", exposing them to sunlight if that is what they need, and fewer nutrients, thus making them tougher.

Early summer cuttings grow new shoots and not flowers, ensuring a better-shaped young plant.

TIP

A good rule of thumb when taking cuttings is that the cutting must pass the "little finger test". A shoot is ready to be taken as a cutting if it resists being bent when one applies gentle pressure with one's little finger. If, however, the shoot bends easily, it is not ready to be taken as a cutting yet.

Water in the mornings. At this time of day the water is applied at more or less the temperature of the soil—this evenness of temperature contributes in keeping fungi at bay. Problems caused by algae and moss that develop and smother cuttings when they are left in the mist or fog for too long, require hands-on management—sick cuttings imply sick plants. If bread is left out, mould grows. The same applies in a mist house—leave dead and decaying plant material lying around and fungus grows and affects the plants. An important principle is the constant monitoring and maintenance of excellent hygiene standards.

One entrance into the propagating unit restricts movement, making it easier to manage from a hygiene point of view. Provide a footbath for visitors and propagators to use before entering. This would help wash away pathogens that may enter the collection via the shoes of workers and visitors. I have seen people leave their personal footwear outside the propagation area and put on

◀ Viscum *sp. in fruit.*
▼ Viscum nervosum *fruit, popped to reveal sticky seed.*

a pair of work gumboots. This is great, but can get very hot in tropical climates. Use Bac 20 or sodium hypochlorite to sterilise the outside of the footwear.

Ensure that the propagation unit is well-ventilated. In our subtropical climate, leaving the sides and upper roof of the mist house open easily does this, but where the climate is colder and temperatures fluctuate, proper sides need to be constructed. Build them in such a way that they can be opened under hot conditions.

There has been some pioneering work done with fibre bags that resemble large tea bags for growing delicate rooted species of *Protea* and *Leucospermum*. This bag makes it possible to plant the cutting or young plant in open ground without sliding the bag off, and so not disturbing the new roots. Fibre bags break down in the soil after a few months, whereas conventional black plastic growing sleeves or bags have to be taken off when plants are planted in the open ground, raising the chance of disturbing the new roots. The supplier of these bags is based near Cape Town and the company is called Balexco.

See the list of supplier names on the inside back cover.

Parasitic plants

Parasitic plants are found in various families like Viscaceae and Scrophulariaceae. This group of plants is difficult to establish, because they are parasites and they need to attach to a living host plant.

These plants offer a good example of the importance of observing specimens in the wild, providing guidance as to how one should go about *ex situ* propagation, for example, in the case of *Viscum*.

Distinguish the main host tree in the area. Check the diameter of the branch that the *Viscum* is attached to. *Viscum* seedlings need to be able to penetrate the conducting tissues of the host to survive. If the bark is too thick, the seedlings cannot survive. On the other hand, the bark may be too thin, raising the chance that the host will shed the parasite.

One method is to grow the correct host plants in containers and attach the *Viscum* to the young plants. Another method is to attach *Viscum* seed, which has been squeezed out of its fleshy outer covering exposing the sticky gum, to the correct sized branch of a suitable host in its natural habitat. I have done this very successfully in our local area with *Viscum rotundifolium* (Anon, Royal Horticultural Society 1998; Visser, 1981).

The methods described above also apply to other mistletoes.

For a more detailed account of this group, refer to "Mistletoes of Africa" by Roger Polhill and Delbert Wiens. It is one of the finest books I have ever seen on a plant family and makes for wonderful bedside reading!

Seed germination of the parasitic representatives of the Scrophulariaceae, in many instances, is specialized because they are suspected of requiring some chemical stimulant that is produced by the host root. Such a mechanism apparently has evolved, not only to ensure that the seed will only germinate in the presence of the host, but also so that the seedlings are close enough to the host's roots to attach themselves successfully. Obviously owing to its minuteness, the seed does not carry much in the way of reserve substances, necessitating the almost immediate acquisition of nutrients from the host once germination has commenced. In only a few genera, the requirement of a stimulant has been unequivocally established, and in the case of Striga asiatica, *it has also led to the identification and synthesis of a chemical called strigol. This substance triggers germination of not only* Striga, *but also* Alectra *and* Orobanche *seed, making it possible to combat these weeds, which are often harmful to cultivated crops by forcing them to germinate in the absence of a host.*

—Johan Visser in South African Parasitic Plants

▲ *Sticky parasitic seed of* Erianthemum dregei *germinating.*
▼ Striga asiatica *(Scrophulariaceae), a root parasite with an affinity for the roots of monocots such as grasses. (Photo: P.S.M. Phiri).*

Succulents

Before venturing into succulents, visit a serious collector to get an idea of how much work is involved. The maintenance and curation of a large succulent collection requires a real passion for the subject and dedicated attention and commitment. This is particularly relevant if you intend growing these plants in a climate that is not particularly suited to their cultivation.

This chapter is based on an interview with Deon Viljoen and Werner Voigt at the Karoo Desert National Botanical Garden in Worcester.

Feeding

As a rule, long-term collectors should rather keep their plants under-fed. Succulents by nature are used to adversity and overfeeding could kill them. Over-fertilising can have devastating effects. Lush growth associated with overfeeding provides an easy target for insects and pests. Most succulents need a resting period, similar to their resting period in nature. Winter rainfall succulents rest in summer, while summer rainfall succulents rest in winter.

TIP

To grow succulents successfully, imitate nature.

Growing houses and ventilation

Roofed structures are best for succulents, especially outside their normal climatic zone. The materials most commonly used to construct structures are glass fibre, polycarbonate, plastic sheeting, and occasionally glass. Tunnel-like structures are popular and simple to erect, but can be impossibly hot in summer if not adequately ventilated.

TIP

A bigger body of air above the plants in a growing house creates an insulating effect that reduces the fierce heat.

Cross ventilation and side panels or windows that can be opened and shut to increase or reduce ventilation are necessary.

Over-heating of growing houses in mid-summer poses a real threat to soft plants. They either boil from severe overheating, or the atmosphere becomes too humid and fungi overrun the collection. Possibly the best course of action under the hottest conditions is to rest the plants and provide more shade. Where there is a bigger body of air present above the plants in a growing house, insulation is created that reduces the fierce heat.

In nature, rocks that are exposed to the sun act as heat sinks by absorbing sun energy during the day and releasing heat at night, and keep plants warm when they might otherwise freeze. The delicate seeds of these plants fall near the rock and have a sheltered, relatively damp place to germinate.

Hygiene and cleanliness

Maintaining a healthy collection requires keeping pathogens and insects that attack succulents at bay. The implementation of rigorous seasonal and day-to-day maintenance plans is essential in securing a valuable succulent collection. In this regard, prevention is always better than cure. In order to maintain a hygienic environment, the floors, raised benches and propagation areas, as well as used pots and containers, should be thoroughly washed with water containing a disinfectant such as Jeyes Fluid.

Incoming plants should be sprayed with a broad-spectrum insecticide and fungicide before placing them in the succulent houses. All tools, for example, secateurs, pruning knives, and trowels, as well as hands, should be sterilised, and hand washed, before and after working with the plants in the collections.

▲ **left** *A succulent propagation house in KwaZulu-Natal;* **right** *Deon Viljoen in the Karoo Botanic Garden, Worcester.*

▲ *A well-ordered succulent collection at the Karoo Desert Garden.*

Standardising pots

Labelling and keeping accurate records are very important activities for any serious collector.

For details, see the section on labelling in Chapter 1.

Collections should be weed-free and look neat. Selecting pots and containers of uniform size, shape, and colour assists in this process and it allows for the setting out of plants in neat rows according to family or genetic groupings.

Other advantages of standardising the pots are reducing costs by buying in bulk, and re-using them after they have been washed and sterilised. In addition, problems resulting from a lack of space can be optimally addressed by using containers of the same size, or even better, square pots, as these take up much less space than round pots.

An ongoing debate exists between growers regarding the advantages of the different container types. Some claim that clay pots are the best, while others prefer plastic. It is really a matter of personal choice. Watering has to be adjusted because clay pots dry out more rapidly than plastic pots. Mixing container types and sizes implies that greater care has to be taken with watering and increased vigilance applied in curating individual plants and the collection as a whole.

Pest control

Daily maintenance of the plants is an essential preventative measure as it may save hours of trouble later. If, for example, a *Gasteria* has an infected leaf, remove the leaf and burn it. As an additional precaution, remove all dead leaves or other plant appendages.

WARNING

Should a pest reach epidemic proportions, the entire collection may need to be treated.

Faced with a persistent pest problem, spray frequently and regularly to break the pest's lifecycle. Once the infestation is under control, check for new outbreaks regularly.

Ideally, the public should be able to view succulents in a display house without touching the plants. There should be plenty of space in the display area to provide free movement and easy access as this limits damage caused when plants are knocked off growing benches by people carrying cameras, rucksacks, and handbags.

Soil

Soil is a major factor in the successful cultivation of succulents. Where possible, soil and rocks should be brought from the natural habitat, as the minerals and trace elements found in these encourage healthy growth. Although a secondary consideration, recreating the natural setting of the plant makes the collection more attractive and appealing to view. The naturalistic planting of species adds interest to the display and makes the difference between a mediocre and top-class display of succulents.

Soil from the natural habitat guarantees greater success with new introductions to the collection. You can plant in the soil from the natural habitat only, or inoculate the initial sowing or planting medium with soil. By utilising soil from the natural habitat, pathogens may be taken from one area to another. To minimise this risk, inoculations should be confined to compact areas such as containers.

Modern growers favour a mixture of equal parts of sieved, good quality (well rotted) commercial potting soil and coarse (1–2 mm diameter) river sand. A layer of rocks, larger stones, like pumice, or granite gravel at the bottom of the pot improves drainage. The essential character of the growing medium is a rapidly draining mixture with enough fine material to anchor the roots.

Miniature succulents generally prefer shallow pans or pots—no deeper than 80 mm—to grow in. Small pots with a 120 mm diameter are best. With the right soil mixture, these tiny plants can thrive in a pot for 20 years without requiring repotting.

▲ Aloe dichotoma *seedlings in inoculated soil.*

Moving plants from one country to another requires permits. Importing and exporting soil with the plants is often a problem, which can be solved by removing all the soil from the plants before sending them off.

Watering

All serious succulent collectors concur that appropriate watering is one of the most important considerations to ensure successful cultivation. They all agree that rainwater is best for succulents.

▼ **left** *Werner Voigt grinding succulent seed capsules at the Karoo Desert Garden;* **right** *Sieving seed to remove chaff and to separate seeds.*

◀ *Succulent seedlings germinating at the Karoo Desert Garden.*

temperatures in one operation.

Propagation from seed

Seed is easy to establish, but takes a while to reach maturity. The seed of the asclepiad succulents takes less that 10 days to germinate. The seed sowing method is simple once the seed has been separated from the capsule. If it is difficult to break the dry capsules apart with your fingers, put them through a mechanical grinder. This process can be tricky for first-timers, as the hardness of the seed capsules can make it difficult. Once the capsules have been ground to a semi-powder state, use sieves of various sizes to separate the seeds.

WARNING

Don't use this method on rare species without trying it out on some common species first.

To obtain viable seed from a collection, a small paintbrush is used to pollinate the flowers. Cross-pollination within species is required to maintain genetic integrity.

Propagation from cuttings

Use a sharp knife instead of a pair of secateurs when taking cuttings. A knife makes a cleaner cut that ensures a reduced amount of trauma to the stem. A smaller amount of tissue damage equals less disease and better propagation success. Stem cuttings are the most common way of growing species such as *Lampranthus* and *Ruschia*.

TIP

A trick that Steve Hammer wrote about is to add a few drops of vinegar or acetic acid to each litre of water if the pH of the water is above 9.

Plants enjoy water in the early morning as this gives them time to dry out while the sun is out and the air temperature is warmer. It is also crucial to control watering according to the seasonal needs of each type of succulent. A good principle is to water the whole collection in autumn and spring to stimulate growth. Some growers in very cold climates go to the length of warming the water before applying it to the plants. Succulents prefer to be sprayed with a mist nozzle or fogger. This washes the plants, helps to discourage insect pests, and lowers high

▼ **left** *Preparing a soft tip cutting of* Gazania rigens *using a sharp knife;* **middle** *Cuttings of succulents at the Karoo Desert Garden;* **right** *Leaf cuttings of* Gasteria *and* Haworthia.

The Conophytums and other fleshy succulents need to be uprooted and divided carefully, using gentle prying and cutting techniques. A scalpel is the best tool.

Cuttings are best taken in autumn, when the leaves are turgid and the hormones are able to stimulate healthy root growth. If cuttings need to be made in summer, this should be done after the plants have flowered. *Kalanchoe*, *Gasteria*, and some species of *Haworthia* grow from leaf cuttings.

Cuttings should be made a few millimetres below the growing point where the base of the body adjoins the woody stem.
—Steve Hammer

Some genera of winter-rainfall species require bottom-heated beds to speed up the rooting process.

Cuttings of Stapeliads need about 14 days to dry out, enabling the cut ends to seal off. Flowers of sulphur can be used to seal the cut. After potting up these cuttings, water should be withheld for a week.

See more on Cuttings in Chapter 3.

Propagating by division

Propagation by division is a slow process and plants have to be handled very carefully. Plants need to be left in a cool, dry area for about 14 days to allow the severed ends to heal and dry. *Haworthia*, *Aloe*, Asclepiads, and some Mesem species can be propagated by division.

Werner Voigt took me on a tour through the Karoo Desert Gardens and sale propagation section. His advice is to grow Vygies or Mesems in the summer from September through to October, as this is when the days start getting longer and the temperatures higher. When many plants need to be produced for bedding areas, he uses open beds because they are much more accessible when dealing with larger numbers of plants.

It is easier to plant these cuttings in the coarsest pure river sand—the aeration is better, there is no compaction, and it does not hold too much moisture. This is ideal for woody species such as *Lampranthus*, *Ruschia*, and *Cephalophyllum*. Smooth-sided gravel encourages algae growth.

Adequate drainage prevents the roots from becoming waterlogged and is essential in ensuring the successful cultivation of Mesems and other succulents. Use seaweed as an organic food supplement.

Taking cuttings from the species that grow easily works best. The less prolific species grow better from seed.

All the propagation areas in the Karoo Desert NBG use under-bed heating cables to keep the temperatures at 22°C–25°C. Light is not usually a problem in southern Africa, but attention must be given to providing adequate ventilation. Sufficient shade needs to be provided in summer.

Anthony Hitchcock at Kirstenbosch advocates use of a pre-emergent fungicide. He believes that enough light and ventilation are crucial during germination, as this is when plants are at their most vulnerable. He suggests that variables such as temperature and moisture should be kept as constant as possible.

Feeding of seedlings is important, with most growers recommending a dilution 1:20 of liquid fertiliser applied during normal watering.

Polystyrene balls are also useful, as they retain heat in the soil and prevent the medium from compacting or drying out too much.

▼ *Polystyrene balls used in a growing medium.*

Chapter 6

Plant families

In the following sections, I discuss each plant family, providing you with detailed notes on suitable propagation methods. These notes are based on literature searches and knowledge gained through experience. It includes accounts of my own and other people's experience in the field.

The possibility always exists that species are grown successfully, but that nobody knows about them. It is very important to document these successes, as well as the failures. This will help others who are looking for the best way to propagate these plants.

Acanthaceae
Acanthus family

I have had some fun recently growing a whole range of plants that belong to the family Acanthaceae. It started with propagation from cuttings of *Metarungia longistrobus* and seed of *Justicia*, *Peristrophe*, *Duvernoia*, *Dicliptera*, and *Hypoestes*, followed by cuttings of *Barleria*, and finally a new species of *Metarungia* for South Africa—*Metarungia pubinervia*—discovered in the Krantzkloof Nature Reserve.

This family of plants supports a whole host of fauna, implying that the more species you have in a garden, the better for the local wildlife, particularly butterflies.

The seed of all members of Acanthaceae has a capsule that splits open longitudinally to scatter two or four seeds into the environment. The textures of the individual seeds of each genus and even between species vary. The seeds are usually flattened and roundish in shape.

Collecting

To start the process, find a plant that has finished flowering. Look for the capsules amongst the bracts. Be careful, as these often have a sharp spine or two, especially the capsules of *Hygrophila*. The capsules should have started to change from green to a tawny straw colour. Place these capsules in a paper packet (to allow air exchange and prevent rotting) on a warm windowsill and wait for the artillery barrage to begin. Always close the packet to prevent seeds from scattering all over the place.

▲ *Seed of* Asystasia gangetica *(centre) and* Ecbolium *sp. (far right).*

Sowing

Once the seeds have been shed from the capsules, use a tray and sow the seed onto the seedling mixture. The seedling mixture should be free-draining to ensure that the young roots do not become waterlogged. Most species germinate where there is plenty of light. If a species is shade-loving, move the tray into the shade once the seeds start to germinate. Always ensure that you are able to keep the soil temperature up to encourage growth. In southern Africa, enough light is not a problem for germination or growth.

Pioneer species, such as *Justicia*, do better if seed is sown *in situ*. The young plants develop faster. *Isoglossa woodii*, *Dyschoriste depressa*, *Justicia flava*, *J. capensis*, *J. betonica*, and even *Rhinacanthus gracilis* are examples of plants that are successfully propagated from seed. *Hygrophila auriculata*, which lives in boggy habitats along river and stream edges, is also best grown from seed scattered in its own habitat. I often prick out plants germinated *in situ* to start new populations in other wetland areas.

Once the first proper leaves are produced, prick the young seedlings out into their own packets or into the ground where they will be growing.

Cuttings

Most members of Acanthaceae grow very easily from cuttings. Growth occurs from tip cuttings taken when the plants are growing actively. Rooting takes place within ten to fourteen days if the bed is bottom-heated and there is mist to keep the shoots cool.

▲ Metarungia pubinervia *seed capsule.*
◀ Metarungia pubinervia *flower.*

Barleria repens, *B. obtusa*, *B. obtusa* x *repens*, *Dicliptera heterostegia*, *Dyschoriste rogersii*, *D. depressa*, *Isoglossa woodii*, *Justicia betonica*, *J. protracta*, *Phaulopsis imbricata*, and *Asystasia gangetica* root readily and grow in virtually any soil, and under any conditions regarding moisture or water content.

More mature stems should be taken from *Blepharis natalensis*, *Barleria crossandriformis*, *B. prionitis*, and *B. repens*, and in some instances *B. saxatilis*, to ensure that new roots are formed. This might be a response to the plants growing in drier habitats and soft-tip cuttings tend to rot off before rooting.

Pests

This family is prone to Australian and Mealy Bug. I find that if the plants are in good condition and not stressed, the insects don't cause too much trouble. Should it be necessary to use insecticides, use only the chemicals registered for these pests.

Woody taxa

The woody taxa, such as *Ruttya ovata*, *Ruspolia*, *Sclerochiton apiculatus*, *Mackaya bella*, *Duvernoia aconitiflora* and *D. adhatodoides*, X *Ruttyruspolia*, *Anisotes formossisimus*, and *Metarungia longistrobus*, *M. galpinii*, and *M. pubinervia* will have no problem growing from stem cuttings, but will take around a month to six weeks to root. All these genera grow easily from seed if you can get it.

Climbers

Climbers, such as *Thunbergia alata* and *T. dregeana* will root, but only in the active growing season from mature stems that have some energy stored to generate roots. My feeling about these species is that they are pioneers and prefer low soil nutrient levels. They struggle if you try to grow them in pots with good soil. They only need a soil rich in organic matter.

AIZOACEAE. SEE MESEMBRYANTHEMACEAE

ALANGIACEAE

Although the number of *Alangium chinense* in the wild is low, it is pan-tropical and grown elsewhere in the world. According to the Royal Horticultural Society encyclopaedia, propagation is best undertaken from seed. *Alangium chinense* can also be grown from soft-tip cuttings, taken in early summer. Grow in a mistbed or cold frame with bottom heat (Brickell, 1989).

(Illustration from Beentje, 1994.)

Amaranthaceae
Pigweed family

The dry country species of Amaranthaceae that occur in Namibia are ideally suited to setting seed quickly and then disappearing until the rain reappears in the new season. Seeds are usually fine and hard. The seed of the dry species may need to go through a dry, cool period before it will germinate. The subtropical species that I am familiar with germinate within days of sowing.

Sandpaper the shiny black *Pupallia*, *Cyathula*, or *Celosia* seeds, soak them for a day, and only then sow them in trays in a warm, sunny place. Heated beds are useful. Alternatively, use a plastic tunnel or even a cold frame that will raise the temperature to be higher than outside and maintain it there for a longer period at night.

Propagation from soft-tip cuttings works well in bottom-heated or ordinary mistbeds. Rooting takes place within 10–14 days.

Amaryllidaceae
Daffodil family

Graham Duncan and I both regard cutting up a bulb into pieces to increase bulb numbers a risky operation, but it has been proven successful in the case of certain Amaryllidaceae genera, such as *Nerine*, for which the 'twin scaling' method can be used. The bulb is cut into four or six equal parts, so that each part consists of two bulb scales attached to a portion of the basal plate. The twin scales are treated with a fungicide, such as Captab, and stored at about 20°C in moist vermiculite in a polythene bag for a period of twelve weeks. New bulblets form between the two bulb scales and are grown in seed trays for one year until they are large enough to plant into pots. Chopping up a bulb causes trauma to the plant that in turn allows pathogens to enter the damaged tissue. The hygiene of the propagation unit has to be strictly maintained or else unnecessary complications may occur.

See more details in Chapter 3 under the Bulb and Corm section.

Anacardiaceae
Mango family

The Marula (*Sclerocarya birrea* var. *africana*) grows from truncheons, which enables us to select better-fruited varieties. It grows well from seed, provided the seed is cleaned and sown quickly. More than one seedling can be produced per seed, because it is a multi-carpelled seed. Seed germinate all year round. By preventing all the seed from germinating at the same time, the successful passing on of genes is ensured.

Ease of cultivation varies greatly amongst the rest of the family. *Ozoroa* has proven the most difficult to grow, followed by *Loxostylis alata* and *Protorhus*. Growing *Rhus*, on the other hand, has not been too difficult, provided the seed is clean and sown fresh.

Masting also seems to be the order of the day for this family—this is the phenomenon where a whole bunch of trees in an area fruit at the same time, and then do not fruit again for a few years. This pattern is a good reason for collecting more seeds than necessary, as it ensures that there are plants to draw from during the lean years.

WARNING

Smodingium, a tree with corrosive sap, causes an allergic reaction, including blisters, on exposed skin.

Lannea seed grows easily, but stiff competition from birds and animals coming to feast can complicate the process. Some species have a suffrutex or underground stem that should be planted out in the ground as soon as possible to develop without the constriction caused by a container.

Experiment on some of the other genera to see if cuttings might not work as a method of propagation.

Sowing

Clean off the outer flesh and sow the seeds immediately. The seed is recalcitrant and loses viability in a matter of days. Seed generally germinates in about 10 days, but this could take up to 60 days, depending on the heat, water, and light. If seed ripens near the end of the growing season, ensure that the young plants are kept warm during the first winter, particularly if you live in a frost zone. Prevent too much moistness, as this will certainly cause the roots to rot.

Annonaceae
Custard apple family

Members of this family are best propagated from seed. The hard outer cover of the fruit should be removed to expose the seeds within. *Annona reticulata*, and I imagine *Hexalobus* and *Friesodielsia* too, are survival fruit (fruit of wild species that humans resort to when normal domestic crops have failed, because of drought or pests). Often herd boys learn about veld or survival foods when herding livestock during school holidays.

▶ **opposite** Annona senegalensis *fruit being eaten by children.*
▼ **inset** Sclerocarya birrea *seed germinating;* **below** Loxostylis alata *fruit.*

▲ **top** Monodora junodii *fruit;* **bottom** Monodora junodii *seed germinating.*
▼ Monanthotaxis caffra *seeds germinating.*

I have seen *Friesodielsia* in the wild up in north-eastern Namibia. The seeds germinate well; all take about a month to germinate. The seed of the harder woody fruits of *Monodora* is large and brown and germinates quite readily.

When *Monanthotaxis* and *Uvaria* seeds germinate, the testa is left behind, covering the cotyledons. A pair of tweezers can be used to remove the testa.

These plants prefer to be in open ground and take a while to establish. In general, they grow slower than most other shrubby plants.

APIACEAE
Carrot or parsley family

The carrot family is best propagated from seed.

The forbs, such as *Alepidea*, *Pimpinella*, and *Peucedanum,* can be grown from suckers that appear at the base of the plant. When removing these suckers in the new season, ensure that some root is taken with the new plant. Propagation from seed is, however, by far the quickest and most efficient way to cultivate this family. The plants like slightly heavier soil, but take care that it doesn't become waterlogged

Heteromorpha arborescens and *Steganotaenia araliacea* are two tree-forming species that grow from truncheons taken in the spring, about two weeks before the new leaves appear.

Seed of *Alepidea* stains one's hands orange and has a strong, clean, antiseptic smell. Clean the seed and sow it within a couple of days of harvesting for the best germination results. Seed germinates within approximately 14 days (Crouch *et al.,* 1999).

Another plant that I would like to see in cultivation more often is *Berula erecta*. This streamside plant likes its feet wet and head in the sun. It is used medicinally in KwaZulu-Natal.

◀ Alepidea amatymbica *in cultivation.*

▼ Adenium swazicum *plant in cultivation at the Skukuza Nursery in the Kruger National Park. Note the many seed follicles on the plant. Because the plant is growing in captivity in its natural habitat, the insect pollinators are able to get to the flowers. This means a ready source of seed near your nursery, easily harvested and grown on. (Photo: Llewellyn Foxcroft.)*

APOCYNACEAE
Periwinkle family

This family now includes the Asclepiadaceae and the Periplocaceae. Plants are easily grown from seed and cuttings.

Sowing

Clean the seeds to remove the silky-haired parachutes and then sow them on a well drained, light, sandy soil mixed with compost. A 1:1 mix of soil and compost is best.

Keep plants well ventilated in good light. Dry the plants out in the dormant season.

Cuttings

In my experience, cuttings of *Adenium* grow well if allowed to dry out for a week or so before being placed in the rooting medium.

Take cuttings in the period just before the growing season starts until about two months before it ends. Treat the fresh wound or cut with a fungicide or flowers of sulphur. Use sterile tools when taking cuttings—a concentration of 1% of sodium hypochlorite acts as steriliser. Another good sterilant to use is Bac 20. Soak the tools for about 20–30 minutes. Note that stainless steel is pitted and stained in the process.

If grown in the open ground, local insects control pests and the infestations only affect weak, sick plants. It is important to remove these plants to prevent spreading of disease.

The Skukuza Nursery at the Kruger National Park in South Africa grows *Adenium multiflorum* and *A. swazicum*, as well as *Pachypodium saundersii* under trees in semi-shade with abundant leaf litter mulch between the plants. These plants produce thousands of seeds annually.

At the Etosha Game Reserve in Namibia, the large plants of *Adenium boehmianum* produce many seeds that could be germinated annually. Reserve staff could collect the seed annually and send it to the Windhoek Gardens. The *A. boehmianum* plants that I have been cultivating since 1980 flower but do not set seed, because of the absence of pollinators.

▲ Pachypodium saundersii *seed—Kruger Park. (Photo: Llewellyn Foxcroft.)*

◀ Raphionacme hirsuta *follicles, almost ripe. The colour changes to a darker shade when ripe.*
▼ Adenium obesum *seed showing parachute hairs at both ends of the seed.*

Pollination

So far, I have failed to find any published reference to actual field observations of insects or other visitors to *Adenium* or *Pachypodium* flowers, and their pollination mechanism was not established until 1980. In 1934, H.P. de la Bathie considered all species of *Pachypodium* to be self-pollinating (autogamous), because of the pollen that is released directly above the style. He did, however, express surprise at the existence of natural hybrids that would not be possible if self-pollination represented the full story. Plants of either genus do not set seed of their own accord. One is very fortunate if seed pods are ever set on any cultivated plants, even after attempts at hand-pollination. All Apocynaceae that have been tested so far show a strong degree of self-incompatibility, so that two separate specimens are needed to ensure fertilisation. As is the case with most flowering plants, self-incompatibility is not absolute, and there are cases, though rare, of an isolated specimen ripening seed pods.

Although it would seem inevitable that gravity would cause the pollen to drop onto the style head of the same flower, this hardly ever happens. The pollen grains are tacky and hang together in a loose mass, while the enclosure is so rigid that it is difficult to be shaken down. All of this proves that De la Bathie's interpretation does not hold water.

The architecture of the flower turns out to be wonderfully coordinated with the structure and behaviour of the pollinator, resulting in efficient cross-pollination (Rowley, 1983). The narrow gaps between adjacent stamens limit access to the nectar, which is secreted at the bottom of the tube around the carpels. The proboscis of the insect feels its way down, touching the wall until it encounters the nectar, which may be secreted from visible glands or merely from the tissue that surrounds the two carpels. The proboscis is then withdrawn promptly and in a more central position, away from the wall. It is at this stage, occupying but a split second in time, that the vital cross-pollination takes place. First, the proboscis is guided between the two adjacent lobes of the anthers, which act as scrapers, drawing off any pollen brought in from outside against the sticky head of the style. The pollen subsequently germinates, pushes out a pollen tube down the style, and effects fertilisation with the ovules in the carpels.

This is only half the story. As the proboscis continues to retract, it becomes freshly gummed against the style and now picks up new pollen from the mass suspended above. On visiting the next flower, the process of delivery and recharging will be repeated many times during one flight.

When the flower tube is slit open, one can see the

◀ Mondia whitei *follicle shedding seed. Seed of this family often have the flattened look of rolled oats or wheat. Look for this pattern and you'll know the family of seed floating past on its silken parachute. Seed in South Africa is ripe in late August just as the summer rains begin.*

strands of grey gum, which are drawn off the style and pick up fresh pollen above. It is easy to simulate the operation in slow motion with the help of a needle or bristle. With a little care, one soon finds the correct angle of insertion. Remember that the object of the exercise is to produce seed, which means that two plants produced from different sources are needed.

Nobody knows yet what pollinates *Adenium* in nature. Oleander has its own hawk moth, *Deilephila nerii*, which arrives at dusk and hovers in front of the blooms, inserting its very long proboscis. The wider tube of the *Adenium* flower suggests a large bee, whose proboscis should be about 18 mm long to reach the nectar. Church (1908) noted with regards to allied genera that any insect with too short a proboscis soon gives up the struggle, since it becomes clogged with glue from the stigma—an effective device to deter all but the right agency for pollen transfer.

I hope that by drawing attention to the truly remarkable partnership between flower and pollinator, more attention will be paid in the field to the observation of visitors to the flowers, so that this fascinating chapter in the life history of *Adenium* and *Pachypodium* can be completed.

Fruits and seeds

Following fertilisation, the flower parts of Apocynaceae wither and fall, leaving the two carpels to enlarge greatly. Two horn-like follicles form. They measure 8–18 cm lengthwise and have a diameter of 8–12 mm. When ripe, these split vertically, like the pods of *Asclepias* and Willow Herb, releasing a great number of approximately cylindrical seeds that are 7–16 mm long, with a circle of fine, brownish hairs of 2–4 cm at each end (Rowley, 1983).

Orbea, Brachystelma, and some *Ceropegia* and *Raphionacme* are best grown from seed. Wait until the dry or dormant season before removing these plants from their natural habitat. Use some of the local soil to inoculate the nursery soil to assist in healthy growth. These species do best in relatively shallow trays that allow the soil to dry out between watering. Many of these species have creeping or twining shoots. Provide each container with its own mini trellis over which the shoots can creep and climb. This group is prone to attack from Mealy bug and other sucking insects. Ensure good greenhouse hygiene. Bruce Bayer advises growers of this family, especially of *Stapelia*, "the best insecticide is the sound of the farmer's footsteps through his orchard".

Mondia whitei is considered by many to be rare in the wild. This may seem to be true because of its value in traditional medicine as an antacid. It has become overexploited in certain parts of its habitat. This species is actually common in the wild in both South Africa and Malawi and is cultivated easily from seed.

Raphionacme with its huge, tuberous rootstock is difficult to grow and needs a deep container and good drainage. *Raphionacme* has to be grown from seed or plants lifted carefully during the dry season when it is dormant. In KwaZulu-Natal, seed is ripe in early summer, in time for the rains. This ensures a good start for the seedlings.

▼ Stapelia gigantea *follicles.*

APONOGETONACEAE
Water hawthorn family

See Chapter 5 under Aquatic plants for details of this family. Additional information is available in Jacot Guillarmod (1977) and Zonneveld (1998).

ARACEAE
Arum family

This group of plants can be propagated from seed or by division. The flowers of *Zamioculcas zamiifolia*, *Stylochiton*, and *Gonatopus* are all produced like miniature arum lilies or *Anthurium* flowers—at ground level. Fruits of *Zamioculcas* are produced on the column and are covered in a fleshy, not unpalatable, pericarp.

Clean off the flesh and sow what I suspect to be recalcitrant seeds. Seed germinates within about 7–10 days and grows for the remainder of the season. In the dormant season, the seedling dies down and comes to life the following growing season. This pattern is repeated in all our Araceae of the region. Although plants are quite slow to establish, they survive severe drought.

Zamioculcas is traded in horticultural circles and is allegedly obtained from Zanzibar. It is a highly ornamental species and maintains well in cultivation.

The rhizome of *Gonatopus* is much fleshier and easier to split than the less fleshy rhizome of *Stylochiton* and *Zamioculcas*. Undertake propagation by division during the dormant time of the year.

ARALIACEAE
Ivy family

In my experience, none of the *Cussonia* or *Schefflera* species from Africa root from cuttings or truncheons. The best method of growing these species is from seed, as is the case with both *Cussonia nicholsonii* and *C. zuluensis*. Keep two or three specimens in a collection, because these plants prevent self-pollination. Flowers open at different times, implying that pollen is shed at one time, while the stigma becomes receptive at another.

Individual fruits take a long time to ripen, ensuring the seed is dispersed and distributed over a relatively long period. This means that in order to collect seed, fruiting plants have to be visited often.

Seed

Cussonia seed is grown as follows:

- Squeeze the ripe, purple-coloured fruit; if both seeds are fertile, they will pop out. These seeds are about the size of a grape pip and have a similar shape, but are pale in colour.
- Sow the seeds immediately—they will germinate in about 10–14 days.
- Prick the seedlings out once the proper leaves appear and a tiny caudex has formed at the base of the stem.
- Another trick is to keep the plants in smaller bags so that they can become root-bound. The soil must be well-drained or else the roots will rot. Allow the plants to rest in winter.

Apply the same method to grow *Schefflera*. These seeds do not germinate as readily. If it seems an impossible task, look out for the seedlings that appear in the nursery under the mature trees. In its natural habitat, I suspect that the seeds need to move through an animal's gut and be scarified by an acid. Given the red colour of the fruit of *Schefflera abyssinica*, birds and monkeys probably eat them, performing the task of preparing the seed for germination.

This species is also found as an epiphyte in trees. The seeds are released by arboreal creatures and lodge in tree forks and other places that are rich in plant detritus and where water can reach to wash the seed.

If treated the same way as *Cussonia*, *Polyscias fulva* also grows readily from seed. The fruit and seed of *Polyscias fulva* are much like that of the *Seemannaralia gerrardii*—the fruit is ribbed and rounded and contains one or two seeds, which should be sown fresh. *Seemannaralia gerrardii* is endemic to KwaZulu-Natal.

◀ *The inflorescences and fruit of* Gonatopus angustus, *the Celery Arum. The fruits ripen to a creamy colour and germinate easily. This is an understorey plant restricted to the Sand Forest and Bushveld areas of the South Africa, Mozambique, and Malawi.*
▼ **below left** Zamioculcas zamiifolia *plant;* **below right** Zamioculcas zamiifolia *inflorescence.*

Cuttings

Polyscias fulva grows from cuttings taken in the early growing season when the sap starts to rise. Place the cuttings from the previous season's growth in a mistbed and remove about a third of the leaf area from the leaves on each cutting. This species grows in full sun—it is a pioneer tree.

▲ Cussonia zuluensis *seedlings.*
◀ Cussonia nicholsonii *fruit.*
▼ *The ripe fruit of* Jubaeopsis caffra *ready for harvesting.*

ARECACEAE
Palm family

This family is only propagated from seed. All the species are successfully grown in containers provided their particular needs are met.

See the section on Hard Seeds in Chapter 2.

Phoenix reclinata, *Raphia australis*, *R. farinifera*, and *Jubaeopsis caffra* grow easily if you can get fertile seed. They should all remain in containers because of their fibrous rooting systems (Davies & Pritchard, 1998).

Clean off the outer pulp of the large seed from our indigenous palms, such as *Borassus aethiopum*, *Hyphaene coriacea*, and *Hyphaene petersiana*, and crack the seed coat gently in a vice. This method mimics the molars of an elephant. If possible, plant each seed with a couple of lumps of elephant dung to provide the best form of organic, slow-release fertiliser on the planet. Given the correct amount of water, sunlight, and heat, seeds germinate within 30 days for *Hyphaene* and 45 days for *Borassus*.

▼ *The pericarp of a* Jubaeopsis caffra *fruit removed to show the nut.*

The seed of other palms, such as *Raphia australis*, *R. farinifera*, and *Phoenix reclinata*, should be cleaned and sown immediately.

It is often best to sow *Borassus* and *Hyphaene* seed in the place that you want the palms to grow. The tap-root that the seed develops is very long and conventional plant bags or sleeves are not deep enough to contain them. Some people have suggested growing the palms in drain-pipes, but this is impractical if you are trying to grow these species in great quantities.

I have had success growing *Hyphaene* in large 20 litre black plastic growing bags. Although the bag is not deep enough, the root tip is able to track the circular bottom of the bag. The problem is to remove the palm seedling from its bag without damaging the root tip, which will not make a new shoot from a side root once broken. Great care must be taken when transplanting these palms.

If you are twenty-five years old, grow a *Borassus* palm from seed today and you may be just on retiring age when that specimen flowers for the first time! Plant palms in a small grove of at least seven individuals to ensure cross-pollination and fertile seed when they eventually fruit.

▲ Borassus aethiopum *plant in fruit.*
▼ Borassus aethiopum *seed. Each fruit has three seeds that are as large as the palm of a human hand.*

ASCLEPIADACEAE. SEE APOCYNACEAE

ASPHODELACEAE

Aloe family

The members of this family are relatively easy to keep in cultivation. The genera typical of this family in southern Africa include *Aloe*, *Astroloba*, *Bulbine*, *Bulbinella*, *Gasteria*, *Haworthia*, *Kniphofia*, *Poellnitzia*, and *Trachyandra*. The best ways to propagate these plants are

▼ Raphia farinifera *seed found in Malawi.*

through vegetative means for maintaining varieties and by seed to increase numbers. The succulent species are relatively slow, but steady in their growth.

The succulent winter rainfall species need special growing conditions. They only really do well in specialist living collections in botanical gardens and with private growers. The principle advocating the use of soil from the original habitat of a species is clearly demonstrated at the Karoo Desert National Botanical Gardens in Worcester. Approximately only 10% of seed from *Aloe dichotoma* sown in a seedling mix germinates, compared to a germination rate of 70% of seed sown in soil from the natural habitat.

▲ **main photo** Aloe microstigma *and* Aloe castanea *in cultivation;* **inset** Aloe dichotoma *seedlings in inoculated soil.*

See Bulbs in Chapter 3 and Succulents in Chapter 4 for details.

Haworthia limifolia
Propagating a medicinal succulent plant

by Geoff Nichols

Haworthia limifolia, known as the File-leaf Haworthia or umathithibala (Zulu), is common in the various medicinal plant markets around South Africa, especially in KwaZulu-Natal and Mpumalanga. The plant occurs naturally in the inland eastern areas around Vryheid, Louwsberg, Pongola, and in the Lebombo Mountains in South Africa, and also in Swaziland and Mozambique. It seems to like elevated grasslands along the tops of hills and ridges. I have found two locations in the wild in KwaZulu-Natal where it is locally abundant. The plants are much camouflaged in amongst small stones and clumps of grass.

I have grown this plant for many years and most of the observations were recorded while I worked at the Silverglen Medicinal Plant Nursery in Chatsworth, Durban.

▲ Haworthia limifolia *at Bridgevale Nursery, Durban, with Bruce Bayer inspecting forms.*

Life cycle

Plants generally flower at the same time during the winter months, starting in June through to September or October. Young plants flower from about 4 years. A bee that has not yet been identified pollinates the flowers during the warmest part of the day.

Seed capsules ripen in the early spring ready to release their seeds to coincide with the beginning of the spring rains. The capsules that ripen later are parasitised by a beetle larva. I assume the winter flowering helps to get most of the seed produced before the seed predators arrive on the scene. I have never seen the plants in the wild in flower or seed or even any evidence of old inflorescences—possibly fire or grazing animals had removed this evidence. On average, each plant will produce two or three inflorescences with about 20 capsules on each inflorescence. Each capsule will have about 25 seeds in it. That is about 1,000 seeds per plant under optimum conditions.

Some plants won't flower if the growing conditions are too favourable or too shady. Haworthias like strong reflected light rather than direct light—direct sun causes sunburn. I copy what goes on in nature by growing the plants under 20–30% shade cloth. If you are not able to use shade cloth then have a row of taller plants between the rows of *Haworthia* that will provide some shade with their foliage during the hottest part of the day.

▼ **left** Haworthia limifolia *for sale in a medicinal plant market in Durban;* **right** Haworthia limifolia *growing in the wild in northern KwaZulu-Natal.*

Sowing

Seed is 100% viable in the first 3 weeks, after this time the viability drops off considerably. It is advisable not to store seeds; they are recalcitrant. Sow as soon as the capsules turn a straw colour and begin to split. I speed up the process by manually splitting the capsules to release the seeds. The seeds are like those of any *Gasteria* or *Haworthia*—black and flaky in shape and texture.

The seeds are placed on a mist bed with bottom heat at 25°C. Seeds germinate after about 5–7 days and initially grow quite slowly. After about one month, the first proper leaves are produced. The seedlings are then pricked out into seedling trays with twenty plants per tray. The plantlets then remain in the tray for the first growing season. After the winter dormancy, they are potted on into individual pots until they are ready for sale.

Tissue culture

If you have tissue culture labs at your disposal, place seeds on agar in the tissue culture lab to get the most even and best results. This process is done to get clean sterile material to tissue culture the plants when you only have a few mature plants. Once there are 60 plants in the mother block, the conventional seed propagation route is the most cost-effective.

Cultivation

Grow *Haworthia* in well-drained sandy soil with plenty of organic matter. I use a 1:1 mixture of river sand and compost. In the beginning of spring, use a sprinkling of hoof and horn fertiliser on the soil surface. In the summer months, from the beginning of September to the end of March, I feed the plants weekly with a liquid fertiliser. Plants will become root-bound in a pot, but as long as you feed regularly during the growing season, the plants will spill over the side of the pot and grow well. *Haworthia limifolia* does propagate vegetatively by producing side shoots or suckers. Some clones produce these more freely than others.

▲ Haworthia limifolia *in cultivation, Durban Parks Department.*

Estimating the age of *Haworthia* is not easy if you don't have a control set of plants from which to work. I have plants grown from seed of *H. limifolia* that are six years old and they have a total plant diameter of about 100 mm. As the plant enlarges, the leaves get longer in *H. limifolia* and the rosette gets broader.

In the wild, the plants will grow only when it rains and when it is warmer. In tropical areas, they will grow all year round, provided you feed and water them well.

Pests and diseases

I have never experienced serious pest problems with this species. However, if plants are potted into too large a container, the soil will become sour and, owing to too much moisture being retained in the soil, the roots will rot off. Haworthias like to dry out between watering. If the plants lose vigour, mealy bug will attack the young roots and soft tissue at the base of each leaf. Soaking the plant in a Malathion bath is the best treatment.■

◀ Haworthia truncata *in cultivation.*

Aloe polyphylla
The Spiral Aloe of Lesotho

by Geoff Nichols

Aloe polyphylla is one of the enigmas of the Aloe group. It has been given mythological status by botanists, but may be more common than one suspects. According to Khotso Kobisi at the Roma Herbarium, many specimens were found in southern Lesotho. The plant has cultural significance, because it is used as a charm to keep lightning away from the homestead. Given this fact, every home in Lesotho must be growing these aloes, which would suggest that its future is secure. The next logical step would be to bring it into cultivation on a major scale by both the authorities and local people. The staff at the Katse Botanic Gardens are growing *Aloe polyphylla* seedlings, strengthening its future.

Prof. Hannes van Staden at the University of Natal in Pietermaritzburg has worked on another method of propagation using tissue culture.

The plant is relatively easy to propagate and grow in tissue culture as was proven by Ramsay and Gratton at Kew in 2000 and Chukwujekwu and van Staden in 2002. This plant is rare in the wild and the pollen is incompatible, meaning that unless there is a number of different clones to ensure cross-pollination, a genetic bottleneck is formed that could lead to the demise of the species if you attempt to reintroduce only one clone of this plant back into the wild. A solution is to plant tissue cultured plants near wild populations to enable the pollinators to cross-pollinate the flowers.

Another problem is that these plants live at high altitude in Lesotho. Growing *Aloe polyphylla* at relatively low altitude increases the risk of certain pests infecting them, as they are immune only to pests living at the same high altitude. This in turn causes cultivation problems for the

▲ Aloe polyphylla.

propagator. Species collectors would love to grow this plant but they would need specialised conditions like an Alpine House to grow it successfully. It is therefore better to keep *Aloe polyphylla* in its habitat at high altitude and collect seed from the wild plants. It is easy to grow plants from collected seed and to maintain these under cultivation at altitude.

This particular aloe has become a flagship species, but there must surely be other endangered plants that need to be propagated and grown on in these high altitude regions. A way of making these plants popular is to write about them, and make seed or plants available legally through various alpine societies around the world. Alpine Society members will help in sharing the knowledge with local Lesotho staff members on how to propagate these specialised plants from the roof of Africa.

Another thought about *Aloe polyphylla* is that it is really a wetland species! All the articles I have ever read on this species is that it grows on rock plates that are well drained and constantly flushed with seepage water. Most growers try to treat the Spiral Aloe as a normal succulent. Ernst van Jaarsveld and Richard Jamieson at Kirstenbosch were the first to try to grow this plant in as near natural conditions as possible, on the top of Table Mountain (Van Jaarsveld, 1984).

This method of matching altitude and habitat, however, is important in the attempt to grow these plants *ex situ*. If altitude is lacking, grow the plants on a slope with artificial seepage water if you cannot find a site with natural seepage.■

▲ **top** Aloe polyphylla *tissue culture plants;* **bottom** *Hannes van Staden and Mariana Ivanova with* Aloe polyphylla *cuttings.*

Aspleniaceae
Spleenwort family

Several spleenwort (*Asplenium*) species are proliferous and they produce young plants at the base or apex of the lamina.

- Place a small pot containing a suitable soil mixture under each of these fronds.
- Pin the small plant, still attached to the mother plant, down onto the soil in the pots.
- Once established, remove these plants from the mother plant by cutting the rachis.

See Air layering in Chapter 3.

Avicenniaceae
Mangrove family

The white mangrove (*Avicennia marina*) germinates while it is still attached to the parent plant. The seedling is the pioneer of mangrove swamps in southern Africa.

For some interesting notes on these trees, see the booklet titled *In the Mangroves of Southern Africa* by Patricia Berjak and colleagues (1977).

Asteraceae
Daisy family

Daisies generally have parachute seeds. The parachutes should be cleaned off to improve the seeds' ability to absorb moisture. Sow the seed and lightly cover with a 1 mm thick layer of seedling mix. This helps to hold the seed in place in the tray or seedling bed.

Chrysanthemoides and *Osteospermum* are examples of fleshy-seeded plants. Once the seed has been cleaned, sow it on the seedling mix at a depth equivalent to its diameter. The seedling mix should be well drained and the

▲ **top** Avicennia marina *forest;* **bottom** Avicennia marina *flowers are rich in nectar and visited by mainly sunbirds who act as pollinators.*

seed trays kept in a warm, well ventilated, and well-lit place.

To prevent germination or deterioration while storing seeds, keep them in a cool place, like a cool room or the bottom of a fridge, where temperatures range between 2°C and 4°C.

Soil from the original habitat helps to inoculate the mix with soil organisms, which promotes healthy growth (Straker, 1989).

Cuttings

When making cuttings from large, tree-like species such as *Vernonia*, *Brachylaena*, and *Tarchonanthus,* concentrate on the hard wood from the last season's growth.

Soft-tip cuttings can be taken from the more scrambling, scandent species, such as *Arctotheca* species, *Dimorphotheca* species, and *Gazania rigens* in spring and during the growing season.

▲ Senecio medley-woodii *seed being collected.*

▼ Chrysanthemoides monilifera *has fleshy, tick-like fruits with a hard seed within. It is known as Bone Seed in other parts of the world where it has become an invasive weed.*

special feature

Gerbera aurantiaca
The Hilton Daisy

by Isabel Johnson & Brian Tarr
Natal National Botanical Garden
South African National Biodiversity Institute

▲ *Monkey beetle pollinator on* Gerbera aurantiaca. *These beetles use the daisies as a food source and as rendezvous platforms to meet and mate.*

Gerbera aurantiaca (Asteraceae), better known as the Hilton Daisy, is a long-lived endemic of moist mist belt grasslands in KwaZulu-Natal. These grasslands have been largely destroyed by commercial forestry, agriculture, and urban sprawl; the resulting fragments are widely scattered. Now, only 12 isolated populations of *G. aurantiaca* are known, some of them only a few acres in extent. The species was classified as Vulnerable by Hilton-Taylor (1996). It is extremely urgent that these remaining populations are conserved.

The Natal National Botanical Gardens is carrying out a conservation study of *G. aurantiaca* as part of a Threatened Plants Programme funded by SABONET. The project involves studying the population biology of the remaining wild populations, as well as establishing representative *ex situ* populations in the Gardens. Since the Hilton Daisy is notoriously difficult to grow in cultivation, the latter presented some challenges. We are still in the initial stages of understanding its propagation. Additionally, we have had to be extremely careful to remove minimal numbers of plants from the wild. Many of the observations described here are both preliminary and tentative, because we have had little experimental parent plant material.

Plants of *G. aurantiaca* reproduce sexually by means of seed, and produce new plantlets vegetatively, to form clones that may reach over a meter in diameter in time. Although viable seed is set, young seedlings are seldom seen in the wild populations..

As most habitats of the remaining populations are now burnt annually, the effect of fire on seedling survival may be significant. Seedlings germinating in November would only be six months old before the growing season ends, and may not have developed a sufficiently robust root system to withstand the effects of fire.

Cultivation

Gerberas should not be over-watered and need to be grown in full sun in well-drained positions. When plants are not watered in winter, they will die back and become dormant during the colder months. Watering should be avoided to prevent rotting of the crowns during the dormant period.

Diseases

While pests rarely bother healthy Gerberas, aphids, whiteflies, mites, and leaf spot can attack plants in an unsuitable environment. Fungus and stem rot is a common problem with over-watered plants.

▼ **left** *The silver-edged leaves and bright red inflorescences of the threatened Hilton Daisy, flagship species for KwaZulu-Natal mistbelt grassland*; **right** Gerbera aurantiaca *seed, showing the parachute-like pappus hairs which aid in dispersal.*

Germination

Seed is produced in October and November following the spring and early summer flowering. Preliminary crossing experiments indicate that the plants are self-incompatible. The fruits(cypselae) are hairy and have a pappus or ring of bristles, which presumably aid in dispersal.

There does not seem to be any dormancy period, and seed germinates within a week under suitable conditions. However, seed does not remain viable for more than a few months after ripening.

We have achieved germination percentages of more than 80% under standard conditions of 25°C, intermittent misting, and using commercially produced fine pine bark seedling mix as germination medium. Attention must be paid to hygiene to prevent fungal attacks of seedlings.

Seedlings

Seedlings can be pricked out at the two-leaf stage and transferred to grassland soil in seedling trays. Seedling mortality is high (over 50%) in the first year. We are still unsure whether this is due to pathogen infection or a genetic-based lack of seedling vigour and we plan to carry out trials using seed treated with fungicide.

Most seedlings die back during the winter months (May–August) and watering should be minimal to avoid rotting of the dormant crowns. In late August and September, the first small, felt-backed leaves appear. Once the seedlings reach the six-leafed stage, they are ready for planting out into raised nursery beds.

The small plants appear to respond well to organic fertilisers. Seedlings transplanted into pine-bark potting medium fail to thrive.

Division

Plants removed from the parent clone can be transplanted into pots containing topsoil from grassland areas and kept in mist house conditions until rooted. If possible, division should be taken in early spring, to minimize the damage to the plant's roots when dividing or transplanting.

Basal cuttings

We are currently investigating propagation by means of basal cuttings, a technique frequently used in the case of the Barberton Daisy *(Gerbera jamesonii)*. Basal cuttings should be taken in spring, and the addition of a rooting hormone may increase success and shorten the time needed from cutting to potting on.■

▶ Gerbera aurantiaca *with* Eriosema kraussianum.
▼ *A field of* Gerbera aurantiaca, *one of the highlights of mistbelt grasslands in October and November.*

▲ Impatiens cecilii *growing next to a waterfall in Zimbabwe. (Photo: SRGH.)*
◀ Impatiens flanaganiae *tubers dormant during winter.*

BALSAMINACEAE
Balsam family

This group of plants is restricted to the forested areas of our continent. All the species of *Impatiens* that I know depend on high humidity with a significant change in evening temperature. The forest-loving species need cool conditions at a high altitude. They expire in the heat of summer under humid conditions at low attitude. They need plenty of water—some species even grow in forest streams.

My advice to people wanting to maintain *Impatiens* species in cultivation is to feed them well during the growing season. As in the case of *Plectranthus*, keep rejuvenating the collection to enable you to stay ahead of the eelworm. Make cuttings or gather seed.

Seed germinates in a matter of days if sown as the capsule explodes. Plants grow rapidly and need a high nutrient regime. It is important that plants do not become water-stressed in the growing season—it makes them an easy target for attack by pests.

The tuberous species become dormant during the dry season. To propagate these species, carefully split the tubers from the main tuber during the resting phase, just before growth starts anew in the following season. Cut tubers in half and make sure that the cut seals to prevent pathogens from attacking the plant. Tuberous species grow in humus-rich soil. I have found them growing in clay soils on forest floors with their roots spread sideways to anchor the plants.

BEGONIACEAE
Begonia family

Begonia capsules consist of three chambers, filled with seed. As the capsule dries, the lower section, furthest from the stalk end, opens to release the thousands of small, brown, dust-like seeds, which float off in the air.

▲ *An immature* Begonia dregei *capsule opened to show the tiny seeds within. When ripe the seeds are brown in colour and resemble dust. The capsule splits from the furthest (distal) end, and releases the seeds into the air as they are shaken or battered by raindrops.*

Surface tension created by mist or raindrops also draws seeds out of the capsules. This is an effective method of dispersal, causing the minute seeds to float away. The seed is often trapped against the trunk of a tree or amongst rocks, where it germinates. Most of our local Begonias are either epiphytes growing on the trunks of trees in amongst the mosses, ferns, and orchids, or lithophytes growing on rocks or rock faces and on ledges where the soil is shallow and rich in humus.

Our African *Begonia* species are best grown from seed. The seed is fine, dust-like, and should be treated like all other fine seed. If sown fresh, *Begonia* seed will germinate in 10–14 days. Older seed can take up to a month to germinate. It is of great importance to keep the seed moist, warm, and exposed to light to induce germination. A high light intensity tends to keep fungal spores at bay, but once the seed has germinated, the light should be reduced somewhat to prevent sunburn. It is a case of finding out through trial and error, as each region in the country has slightly different conditions, requiring one to adapt accordingly. This is the critical stage when fungal diseases, attracted by the humid, warm, and moist conditions, attack the seedlings. Treat seedlings proactively with a good drench of fungicide over the soil and the seed—prevention is better than cure.

For details on sowing fine seed, see Fine Seed in Chapter 2. Also, see the vegetative reproduction section for leaf cuttings in Chapter 3.

Some of the rock surface growing species, which spread their roots over virtually no substrate, like *Begonia sutherlandii*, will grow over a damp brick, but feeding is crucial to successful cultivation (Kendle & Lloyd-Bostok, 2000).

Cuttings of the caudex-forming species (like *Begonia sonderana*, *B. homonyma*, and *B. dregei*) root in the spring or early in the growing season. The tuberous species also root, but cuttings should be taken very early in the season to enable a tuber to form that would last the plant through the dormant winter or dry season. (Refer to the Tubers section in Chapter 3.)

Altitude and cool humidity are important factors to ensure successful cultivation of many of our species. Grow the plants at the same altitude or climatic region. Do not bring the endemics from the tops of mountains down into the warm lowlands where they will not adapt.

▲ **top left** Begonia dregei *caudex;* **bottom left** Begonia sutherlandii *growing in Nkandla, KwaZulu-Natal, South Africa;* **right** Begonia sutherlandii *makes a very attractive container plant.*

▲ Fernandoa magnifica *flower.*
▼ Fernandoa magnifica *seed showing the typical winged seed of the family Bignoniaceae.*

BIGNONIACEAE
Jacaranda family

This plant family has the potential of becoming invasive, as the survival percentage of seed is very high. The seeds are usually winged with papery wings at both ends of the seed, or tight around the seed in one plane. The seed germinates in less than 10 days, provided the soil is damp and warm. Cover the seeds with soil or seedling mix to hold the seeds in place during watering. *Fernandoa magnifica* grows easily from seed. Propagators need to find trees with capsules and collect seed when it is ripe.

Most members of this family are propagated successfully from soft tip and semi-hardwood cuttings at the beginning of the growing season. Tree species may benefit from hardwood cuttings.

BOMBACACEAE
Baobab family

According to Palgrave's Tree Book, *Rhodognaphalon mossambicense* is now known as *Bombax rhodognaphalon* (Palgrave, 2002). Brendan Fox and Kenneth Robb assert that it is relatively easy to transplant this tree in the sandy soils where it grows naturally. Move these plants in the dry season, about 3–4 weeks before the rains start.

These plants are best propagated from seed. Remove seed from its hard outer casing and the fluffy hair in which it is embedded. Nick the seed by sandpapering the coat and soak the seed overnight or until it starts to swell, before placing it in the seedling medium. Sow it in well-drained, sandy soil. Germination takes place within about 3 weeks.

The Baobab (*Adansonia digitata)* is a classical example of this group of plants. Although it transplants easily, this family is the largest of our African succulents and the size can be a limiting factor when attempts are made at moving them.

The procedure for preparing the seed for sowing is the same as that for *Bombax rhodognaphalon. Adansonia* seed has a fleshy outer covering instead of the hairy covering of *Bombax*. Chit or nick the seed for quick germination.

▲ Bombax rhodognaphalon *flower. (Photo: Kenneth Robb.)*

▼ Bombax rhodognaphalon *tree. (Photo: Kenneth Robb.)*

▲ Bombax rhodognaphalon *fruit. (Photo: Kenneth Robb.)*
◀ Bombax gnaphalocarpon *fruit, opened, ready to shed seed.*

BORAGINACEAE
Forget-me-not family

Cynoglossum alticola is relatively easy to grow from seed, provided the seed is collected before animals moving past the plants have a chance to disperse it. The seeds are presented high at the end of the old inflorescence in grassland. The fruits are four nut-like structures joined together. The testa bears hook-like bristles or hairs, which enable the seed to attach itself to any furry animal that brushes against it. In the dormant season, the partially woody underground stem can be cut into pieces of about 150 mm. These pieces will re-sprout and root in the new season.

▲ Cordia caffra *seedling showing the pleated cotyledon of this genus.*

Ehretia rigida is best propagated from seed, and although I have not tried cuttings, I suspect that semi-hardwood cuttings will work if taken in spring. Layering may work well to propagate *Ehretia rigida*, as it suckers from damaged roots. *Cordia* is best grown from seed, which germinates readily, provided the outer flesh has been cleaned off before it is sown. Germination takes place in about 14 days or less if the weather is warm and the soil is damp. The cotyledons of *Cordia caffra* have an interesting pleated shape.

I am not familiar with *Cystostemon*, but I would suggest that the plants are visited regularly to monitor seed maturity. Collect the seed, remove the testa and sow—follow the same procedure as for the other boraginaceous species.

BURSERACEAE
Myrrh family

This is a group of plants that is well suited to the harsh African continent. Collect seed and remove the red aril. Seed germinates within about 14 days. Many species will also grow from cuttings, but as I am not familiar with the Namibian contingent, this calls for experimentation. Species from the extreme desert areas should be treated like succulents. Water only when the soil has dried out and only in the so-called "rainy season". Keep the plants hot and well-drained, especially if grown in containers.

Commiphora neglecta is grown from seed in late summer. Root cuttings also work well. Break off bits of the succulent roots and lay them in river sand—shoots will appear in a couple of months. Propagation from normal cuttings or truncheons does not work at all. See front cover (seed and fruit) and page 35 (truncheons).

BUXACEAE
Box family

I believe that this group of plants is probably the slowest-growing of southern African woody plants. Like *Buxus nyasica* in Malawi, the two species in South Africa that are known to me have a very disjunct distribution. Specimens might be found in a section of a forest, but not throughout the forest. Propagation works best from seed, but the plants grow slowly, if steadily. Seed is shiny black and hard-coated. I find that seed of *Buxus natalensis* germinates better if the hard coat is lightly scarified with sandpaper. Sow the seed in the spring, just as the new growing season starts. Germination takes about 2–3 weeks. Seedlings develop very slowly and a five-year-old plant is not much taller than about 20 cm.

The seed of *Buxus macowanii* germinates in about 3 weeks. There are often many seedlings growing under the parent trees. Collect these as "wildings". The leaves of the seedlings up until about 5 years old are thin and fine in texture and do not resemble the leaves of a mature plant at all. This is also the case with the Sneezewood tree, *Ptaeroxylon obliquum*.

CAMPANULACEAE
Bellflower family

I have grown *Wahlenbergia* from seed in a humus-rich, sandy soil with no fertiliser. I collected the capsules just before they split and sowed the seed a day or so after it was shed in the early summer. The trays were filled with seedling mix and seed was treated like any other fine seed. It germinated after about 2 weeks. Young seedlings were planted out directly into the open ground. They are still growing happily a couple of years later.

Cuttings should be taken from tips in early spring and set in sharp river sand with a mistbed and bottom heat.

On the KwaZulu-Natal coast, I have been able to split or divide a clump and increase the number of plants. This method of propagation, however, does not contribute to a greater genetic diversity.

The alpine species of this family form very tight clumps and I suspect that cuttings will strike. Make sure that there is a growing season ahead before attempting propagation by division.

I believe that seed propagation is a better option, but this requires patience and good timing in collecting seed.

CANELLACEAE
White cinnamon family

Warburgia takes root after about 90 days in a mistbed. The alternative is to sever roots of a finger-thickness of a wild tree with a spade and wait for the tree to produce its own new shoots from the cut root. Once the shoot is well established, cut it away from the parent plant. This method is known as ground or root layering (for detail see page 40).

The following observation pointed me in the direction of

▲ Buxus natalensis *fruit with shiny black seed visible inside.*

special feature

Warburgia salutaris

by Richard Symmonds & Neil Crouch

Medicinal value and conservation status

The stem and, to a lesser degree, the root-bark of *Warburgia salutaris* (Pepper-bark tree) or *isibaha* as it is known to the Zulu, is one of the most sought-after medicinal plant commodities in the southern African traditional health care sector (Gerstner 1938; Cunningham 1990; Williams 1996; Mander 1997; 1998; Marshall 1998). Its near-panaceal qualities were early recognised, not only by the traditional users but also by the taxonomist who awarded it the epithet *"salutaris,"* meaning healthful or wholesome (Zimmer 1949). Rather than here listing the various uses (which range from the relief of mouth sores to the treatment of malaria), readers are referred to the accounts of Bryant (1909), Gerstner (1938), Gordon (1953), Van Warmnelo (1953), Smith (1966), Gelfand *et al.* (1985), Mabogo (1990), and Hutchings & van Staden (1994) for such details.

The widespread popularity of *Warburgia* has led to its extensive over-collection and decline in the wild (Gerstner, 1946; Gordon, 1953; Cunningham, 1988; Nichols, 1990; Hollmann, 1994; Mahende, 1994; Hollmann, 1996; Mander, 1998; Marshall, 1998; Scott-Shaw *et al.*, 1998) even within protected areas (Johnson *et al.*, 1995). This threat to its survival has long been recognised, In 1938, Gerstner wrote

"...there are all over the country only poor coppices, every year cut right down to the bottom, used all over and sold by the Native herbalists as one of the most famous expectorants."

A recent global conservation status assessment (Oldfield *et al.*, 1998) has accordingly listed *W. salutaris* as a taxon in danger of extinction (EN Alacd), necessitating a species-recovery approach to its conservation.

In light of this, these propagation notes are an attempt to document, in particular, the shoot-tip cutting technique developed at Durban's Silverglen Medicinal Plant Nursery during the mid-1980s. Following on this success, HL&H Mining Timber collected 500 shoot-tip cuttings from Silverglen and subsequently rooted them at their Tree Improvement Centre at White River (Johnson *et al.*, 1995). From this stock, and materials obtained through nature conservation bodies, 100,000 plants were timeously propagated to promote *W. salutaris* as Tree of the Year in 1996 (De Cock, 1995; Esterhuyse, 1996). Several enterprises and many individuals, including traditional healers (Crouch & Hutchings, 1999), have subsequently benefited from access to these young trees.

Pepper-bark trees have great potential as ornamental subjects. With their glossy foliage, fine oval shape, and fairly rapid growth rate (especially when established in well-composted planting holes), plants make suitable screening subjects. They may also be pruned and shaped into a hedge.

Trees (in Durban) planted substantially south of their normal distribution range have evidently acclimatised to a variety of local conditions. This may reflect their tolerance toward a broad range of habitats (Marshall 1998). However, one can't help but wonder whether *isibaha* did at one time grow around Durban, but has been driven to local extinction through over-exploitation. Such has been the fate of Wild Ginger and bushman's tea. From both a social and economic perspective, more of this highly sought-after medicinal tree should be planted in park landscape and agricultural contexts.

Propagation

Propagating from seed

Growing *W. salutaris* from seed is possibly the simplest and most rewarding way of bulking up this species. However, the voracious attentions of fruit flies and monkeys make the harvesting of viable seed virtually impossible. Fruits ripen between October and December, allowing for cleaning and sowing over this period. Before sowing, the hard brown-black seeds should be removed from the fruit pulp—this process is greatly facilitated by soaking the fruits in a bucket of cold water overnight. Seeds should be sown in trays on a mixture of sieved compost and river sand (1:1) and lightly covered with the same. No pretreatment is required, for seeds germinate readily, and start emerging after about 21 days.

Freshly collected and sown seed should give a return of 80% within 2 months of sowing. Storage of seed is not advised for they are probably recalcitrant (seeds that lose viability after drying out). Seedlings should be left in the trays until they reach 5 cm in height, or the two-leaf stage, when they may be re-potted into 1.5 litre bags in river sand and compost (1:2). Seedlings established from seed sown in December 1996 are now in 6 litre bags and stand 1.5 metres tall.

Shoot-tip cuttings

Propagation using shoot-tip cuttings is currently the best way of bulking up Pepper-bark plant numbers, given the shortage of viable seed. Long tip cuttings are taken, which consist of the top 15 cm length of new apical shoots. Depending on the time of the year that the shoot-tip cuttings are taken, the tip types will vary from semi-hardwood to softwood. Experience has shown that the harder tip cuttings perform better in the Silverglen environment.

▲ **top left** *Ripe fruit (40–50 mm in diameter) of* Warburgia salutaris *stung by fruit flies;* **top right** *Mally Stainbank in front of his* Warburgia salutaris *plantation in KwaZulu-Natal, one of the few plantings of the tree in private hands;* **bottom left** *The beautiful trunks of* Warburgia salutaris *growing in a grove in northern KwaZulu-Natal;* **bottom right** *A hedge of* Warburgia salutaris *used for cuttings.*

Cuttings are best collected early in the morning and kept in a bucket of water during the selection and cutting process. Cuttings embodying 3–4 nodes (8–10 cm, trimmed from the original 15 cm-long tip) are stripped of their lower leaves. A clean cut is made at the base of a node and the top 3–4 leaves are trimmed to reduce the transpirative surface. This cropping reduces the likelihood of the cuttings drying out and perishing. The material is inserted in washed river sand under mist, and the misting timer set to 5-second sprays at 10-minute intervals. The mistbeds are bottom-heated at 24 °C by electrical heating cables. Bottom heating improves the strike rate for it promotes callusing at the basal node, a necessary step in the development of roots.

Rooting

Typically, cuttings take between three and four months to establish before they are ready to be re-potted into 1.5 litre bags of river sand and compost (1:2). Root initiation can be evidenced as quickly as 45 days. The rooting period can be reduced if rooting hormones are applied, or stricter environmental control (for example temperature, mist-drift) is exercised at the mistbed site. However, Silverglen typically undertakes simple, cost-effective propagation protocols —although adequate, these procedures are not always the quickest!

With Durban's relatively moderate climate, cuttings can be taken throughout the year. The average annual strike rate of healthy cuttings has been 52%. The lowest recorded return is 34% for cuttings taken in June, and the highest 73% for those cut in March. The growth rate of plants so propagated is moderate; cuttings taken from a population in Mpumalanga in December 1997 have already been re-potted in 6 L bags, and presently stand about 50 cm tall. These plants are ready to be planted out in Silverglen's *Warburgia* field genebank, which doubles as the mother stock from which the cuttings are taken.

Many variables are involved in the rooting process, such as air temperature, humidity, photoperiod, age and state and source of the mother stock and these have clearly not been adequately controlled in our "experiment". However, despite this, we feel that the pronounced rooting response evident during the months of March and August may be linked to the photoperiod, or day-length. These two months correspond to the spring (vernal) and autumn equinoxes, times of the year when there is as much daylight as darkness during a 24-hour period. One may reasonably ask—why are the cuttings not "day-neutral"? Are they controlling their own response to day length, or are they expressing hormones carried over from the mother stock? The effects of photoperiod are well researched and evidenced in other hormonally driven life processes, the most obvious of which is flowering. Although most angiosperms exhibit a single flowering period, some offer biannual displays. *Plectranthus zuluensis* is a good example, for it flowers well in March (autumn), as indeed most members of the genus do, but then produces a second display in September over the vernal equinox. The prevalent photoperiod, or ratio of light to dark (1:1) likely triggers this process.■

making the first root cuttings from this species—these became the plants at Silverglen. Along the shores of Lake St Lucia, the hippo must leave the safety of the water at night to move on to the land to graze. Hippos are not exactly light beasts and wherever their feet touch the damp soil at the lake edge they leave an impression at least 100 mm deep. This action of foot-on-soil damages the roots of *Warburgia salutaris*—the animal equivalent of the guillotine. Damaged root tips send out shoots and it is these "root suckers" that we have up until now used as propagules.

The roots plus the shoots are gently taken out of the soil and placed in a mist propagation bed in the nursery. After about two months in a mistbed, warmed with under-soil heating cables and supplied with a fine intermittent mist of water over the foliage, the cuttings are ready to be weaned to normal growing conditions. Then after a further two months, the plants are ready to be planted in the open.

Capparaceae
Caper family

In my experience, genera such as *Capparis*, *Cadaba*, *Bachmannia*, *Cladostemon*, and *Maerua* all grow well from root suckers, albeit slowly. The most efficient way to propagate any of these species is from seed. However, birds and animals often eat the fruit while it is still relatively green. In KwaZulu-Natal, fruits will be ripe even though they haven't yet changed colour. Birds are especially good at detecting this.

▲ Cadaba natalensis *fruit with seeds surrounded by orange flesh.*

The woody capsule of *Capparis tomentosa* must be ripe before the fruit is picked. The seed is contained in a rather palatable, mucilaginous, sticky flesh, and needs to be removed before the seed is sown. Either abrade the seed with a mixture of sand and water, or take the seed and place it in about 500 ml of water mixed with a couple of tablespoons of sugar. Allow the mixture to ferment for a few days. When fermented, the flesh will wash off easily.

Use one of these methods to clean the seed of *Boscia albitrunca* and *B. foetida*. Sow the seed as soon as possible to maintain its viability—it takes about 3 weeks to germinate. Transfer the seedlings to their own packets or containers and fertilise with nitrogen. If they do not get enough nitrogen, the seedlings soon take on a yellow, pale look and stop growing. Even with fertiliser, the seedlings seem to stagnate after acquiring about four leaves. In fact, the plant is putting all its energy into making a huge tuber under the ground. It is important to remember that feeding is essential. The plants also like to be fairly root-bound.

Cleome is best grown from seed. Watch the plants closely and collect the capsules just before they split. *Cleome* seed germinates if sown immediately in disturbed soil with not too much fertiliser. Sow seed approximately two weeks before the new growing season is about to begin.

Caryophyllaceae
Carnation family

The Carnation family is relatively easily grown in normal potting soil with adequate nutrient levels. Seed is the best method of propagation—plants produce masses of seed that germinates well in seedling trays. They germinate within about 3 weeks. I have been able to grow *Dianthus zeyheri* from seed without a problem. The seed capsules should be watched carefully and collected as they start to split and shed their seed. Dry the capsules in a tray lined with newspaper in a dry, shady area. Sow the seeds immediately as they are shed. In KwaZulu-Natal, *Dianthus* flowers in early summer and the seed is ready to sow in about 6 weeks. This gives ample time for the young seedlings to germinate and become established before winter. Leave the seedlings in their trays for the first season and prick them out in the following summer.

Other propagation methods for *Dianthus* and *Silene* include tip cuttings and division.

The species of *Dianthus* that are endangered should be propagated as early in the season as possible to allow enough time for the seedlings to become established before winter or the dry season.

Celastraceae
Staff-tree family

This family is relatively easily grown from seed. It is widely distributed in southern Africa.

In my experience, one should wait until about a third of the visible fruit is beginning to split open. Pick a branch that is full of fruit and hang it over a tray or box to catch the fruit when they drop. The seed is usually covered by a fleshy white, yellow, or orange aril. Remove it and sow immediately. (I suspect that this family has recalcitrant seed.) The seed germinates within 2–4 weeks after sowing. Use a well-drained, inert seedling mix. Start adding nutrients only once the little seedlings have been pricked out into trays or bags. I prefer small containers—they provide better support for the roots, which are weak initially. Although not rapid growers, the plants do well once placed in open ground. These trees and shrubs generally tend to produce large amounts of seed, so I haven't yet attempted to grow them from cuttings.

Chenopodiaceae
Goosefoot family

This family is one of extremes. We have many introduced weedy species, as well as our own, native species. They live at the remotest edges of plant growth, either in semi-desert or as dwellers of the most severe salt marsh and semi-marine conditions. I have no experience in growing any of these plants and would like to know of others who might have grown them. My only advice is to try cuttings of the desert species as these may well root. I would suggest the focus is on protecting the habitat of the salt marsh species, rather than *ex situ* propagation attempts.

See if you can collect seed to sow in suitable habitats, undisturbed by humans.

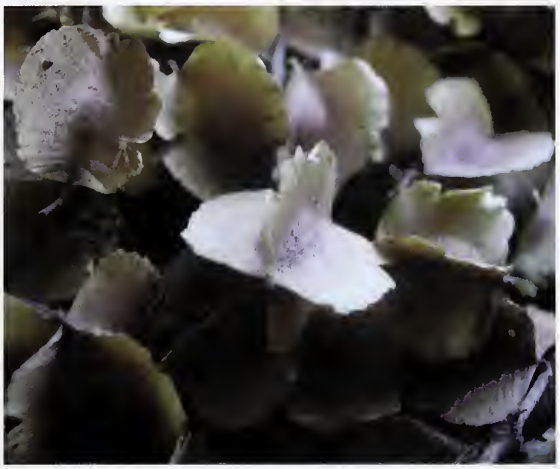
COMBRETACEAE
Combretum family

My experience with this family is that it is best grown from seed. The seed tends to be fairly highly parasitised. Collect as much fruit as you can from as many trees as you can. This takes time and energy, but is worth the trouble, ensuring that at least some would be free of parasites. Gather the fruit in a sack and crush all the wings. This crushing makes the seed less bulky and easier to sow in large seedling beds. Seed germinates within about 14 days, but depending on ambient temperature, this may be as short at 7 days or as long as a month or more in colder areas.

Pteliopsis is sown in the same way and prefers sandy, nutrient-poor soils with plenty of organic matter. Growth is slow in containers, but rapid in the ground. Do not be concerned if the plants grow sideways! The branches will pick up once the lignin is set down in the winter resting months. These plants have a weeping habit and do not need to be pruned too early in their lives.

In the case of *Combretum* and *Terminalia*, carefully remove the actual seed kernel from the outer casing and sow this. In this way, the seed sown is of good quality and seed germination happens quicker. By leaving the outer casing around the kernel, a high degree of seed predation is possible. The Kew Millennium Seed Bank staff X-ray their seed to check for fertile and infertile seeds. It is astounding how the huge cotyledons of the genus *Combretum* can be compressed into one seed.

The rule of thumb I have employed regarding these two genera is that if I want 100 plants, I sow 1,000 seeds. The proportion of germination success is 1:10. Always collect more seed than needed, because it is better to grow more plants than have too few. Furthermore, when huge amounts of energy and time are spent mounting a collecting expedition, it is unlikely that one will return to the location to collect more seed in the near future.



▲ Combretum microphyllum *seeds (Photo: Llewellyn Foxcroft).*
▼ Gymnosporia grandifolia *fruit dehiscing. The aril surrounding the seed is visible.*

CONNARACEAE
Itch-pod family

In some books, *Rourea minor* is the synonym of *Santaloides afzelii* (Beentje, 1994). *Cnestis polyphylla* and *Rourea* species are scandent shrubs, rather than trees. The tree-forming species perform best from seed, but seed may not be produced each season. *Cnestis*, for example, needs full sun to flower. The fruits of this family resemble legume pods. The seed is usually black with a yellow fleshy aril, indicating that it is recalcitrant and therefore important to sow immediately. Remove the outer skin from the seed before it is sown.

I have no experience regarding propagation from cuttings.

INTERESTING FACT

I have observed *Cnestis* plants growing vigorously in a forest, but the leaves were in the understorey and it never flowered. The next season, when I visited the same *Cnestis* plant, there were masses of flowers and fruit. Sunlight, caused by an opening in the canopy created by a collapsed tree, was responsible for the sudden burst of flowers and fruit.

▼ Cnestis polyphylla *fruit.*

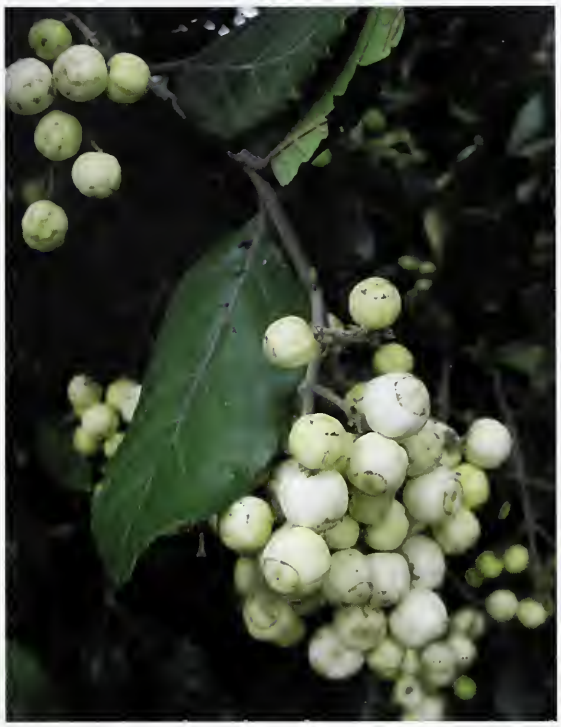
Convolvulaceae
Morning glory family

Cuttings of the creeping species of this family root relatively easily in sand. Layering into the soil around the plants also works, as long as the surrounding soil is kept moist. The time when rooting takes place varies, but it should be possible to move plants within about 3 months. Peg the node to the soil to enable rooting, which takes about 2 weeks. Nick some of the thick stems just below the node and they will sprout roots.

The desert-dwelling species of Convolulaceae rest and are propagated during the following year. In my experience, seed sown at the beginning of the next growing season does better. Store seed in a cool, dry place.

Cornaceae
Dogwood family

Although *Curtisia dentata* is not on the threatened plant list, whenever I have come across it, it has been peeled of its bark. Seed is the best way to grow this plant. This tree seeds well when it flowers. However, much like the Black Stinkwood (*Ocotea bullata*), seed is parasitised in its natural habitat, usually by the larvae of a small beetle. Remove the surrounding flesh before sowing the seed. Seed germinates well in normal seedling mix with heated soil. Grow the seed in a sheltered, sunny place to achieve the best results.



▲ Curtisia dentata *fruit.*

Costaceae

This family is close to the Ginger family and propagating *Costus afer* should be similar to the way all the cultivated *Costus* species are propagated. Division, which involves splitting off pieces of the rhizome from the parent plant, is one method of propagation that could be followed.

Crassulaceae
Crassula or Stonecrop family

Leaf cuttings, stem cuttings, and seed are the best methods of propagation for this family of plants. The seed is very fine and dust-like. Treat it like all fine seeds.

When in the field on a collecting trip, be meticulous to observe the habitat in which you are collecting. At microhabitat level, establish whether the plants grow in deep shade, or are exposed to full sun, whether they grow in well-drained soil or not, and whether they grow in leaf litter or between rocks. Take rocks and stones from the original habitat, as well as some soil to inoculate the growing medium—the minerals leach out into the potting soil.

Cucurbitaceae
Cucumber family

Seed is the best method of propagation and should be dried out and planted at the beginning of the next growing season. Some of the species that have huge water-storing stems, such as *Kedrostis* and *Gerrardanthus*, grow from a divided tuber as long as the growing point is split carefully using a sharp knife.

Generally, cucumbers are creepers and need to be grown on a trellis to allow the stem to clamber over the support. Some species, such as *Zehneria*, are annuals and need to be grown from seed each season.

▼ *Female flower of* Gerrardanthus tomentosus.

▲ *Cucumis humifructus* pedicels grow down into the soil after fertilization and the tennis ball-sized fruit develops underground. (Photo: Jeremy Hollmann.)

In Zimbabwe, Namibia, and South Africa an interesting association exists between a cucumber and the aardvark. This animal eats the fruits of the aardvark cucumber (*Cucumis humifructus*), which are formed underground. The aardvark digs up the fruits, eats their watery contents, and then excretes the seeds in its droppings, which it buries in the sandy soil. Here the seeds germinate during the following rainy season (Hollmann *et al.*, 1995).

INTERESTING FACT

This plant is one of the few plants in the world whose fruits bury themselves (geocarpic or geocarpy) in the soil after flowering. The peanut is another plant that does this (Stent, 1927; Meeuse, 1955).

Cupressaceae
Cypress family

In southern Africa, this group of plants consists of the genera *Widdringtonia* and *Juniperus*. I have no experience with *Juniperus*. Burrows (1995) comments that *Juniperus* grows easily from seed if collected and sown when the seasonal rains begin.

Sow *Widdringtonia* seeds on a seedling mix and cover them so that they are held in place. Heat the soil to achieve a greater germination percentage. Seedlings grow best in relatively nutrient-poor, sandy soil. Expose the young plants to full sun to toughen them up before they are planted out in the wild. Feed the plants every two weeks during the growing season with a liquid fertiliser.

Juniperus seed is a little trickier because of its succulent, berry-like structure.

Once the seeds are removed from the cone, the European junipers need a period of stratification or cooling in a fridge at 2°–4°C for about 18 months. The false berry or cone of our Juniper, known as the African Pencil Cedar, has a number of seeds within the swollen scales that give this cone its berry-like appearance. I am not sure if our African species needs the same period of stratification, but it would be useful to store the seeds. I would even sow some fresh and see what happens.

L. Negash, a researcher in Ethiopia, has successfully propagated *Juniperus procera* from cuttings. He used IBA rooting hormone at 0.4% concentration in cold frames and the cuttings rooted in about 4–8 weeks. He found that soft-tip cuttings of older plants (about 15 months) rooted more vigorously than younger plants of 5 months old (Negash, 2002). Though this method will bulk up stock, it may not give you a good genetic diversity if you are limited to the number of plants that you are able to harvest from.

INTERESTING FACT

Gin is an alcoholic beverage obtained from the female cones or false berry of the Juniper, *J. communis*.

Cyperaceae
Sedge family

As the sedges mostly grow in water, maintenance is simple, given wet, boggy soils and enough sun. Grow these plants in a large, shallow (a maximum of 100 mm deep) trough, filled with river sand only (no soil or clay). Make sure that they receive enough water. Important factors for growing most sedges are enough sunlight and damp conditions. Observe where they grow best in the wild and use that as an indication of their needs. Under the correct conditions, sedges thrive.

Roddy Ward grows all his specimens in individual

▲ *Unripe seed capsule of* Widdringtonia nodiflora.

plastic washbasins. These are ideal for moving the plants around and limiting them to their own space. The suckers that are produced can be split off to make new plants. If the trough is not partitioned, take care that the plants do not grow into each other using their suckers. Seed should be harvested when ripe. To ease the process of finding ripe seed at the right time, a parent plant can be collected and planted in the nursery with its seed intact. The seed will mature and sow itself under the parent plant. Some sedges, such as the *Cyperus prolifer*, produce plantlets on a seed head.

The identification of sedges can prove confusing. To get to know this family you need all the help you can get. Make proper specimens of the whole plant to ease the task of the taxonomist in identifying it. It is quite possible that the plant may have more than one name. Do not despair—the doubt is part of a very exciting process.

Dichapetalaceae

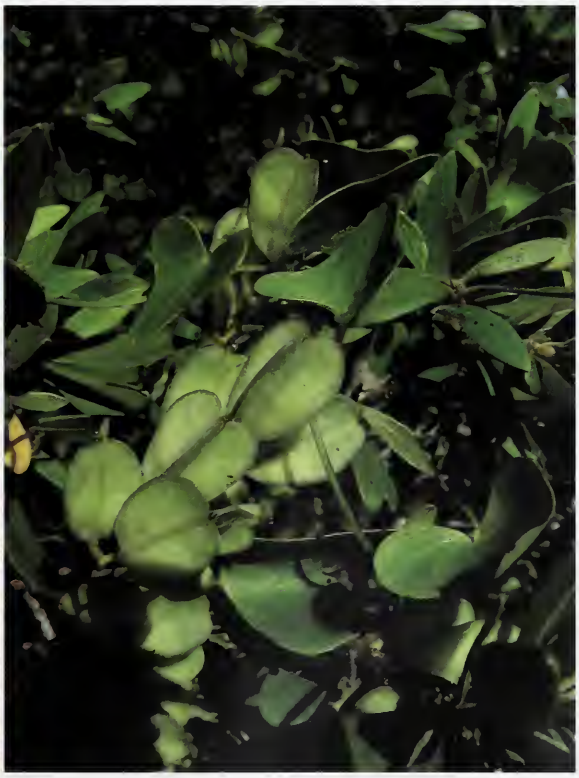
I have only a little experience in propagating members of this family. From twhat has been written on the subject, it seems propagation from seed is the best method. The common *Dichapetalum cymosum*, which occurs inland in the sandy grasslands and woodlands of South Africa, is toxic to livestock. I assume that this is also the case with the other species in southern Africa. Prof. Christo Botha has kindly lent me a picture of the fruits of *D. cymosum*, which is a clear indication that this genus is probably best grown from freshly collected and cleaned seed.

I suspect that the seeds need ample sunlight and moisture for good germination. The seeds are exposed when the fleshy outer covering of the fruit is removed. Since many species seem to be lianas, I would also attempt propagation from cuttings in the new growing season. Local knowledge of plants and close, constant observation will bear fruit.

Dioscoreaceae
Yam family

This family of plants is easy to grow and maintain in cultivation. The four most commonly traded medicinal species in KwaZulu-Natal—*Dioscorea dregeana*, *D. cotinifolia*, *D. rupicola*, and *D. sylvatica*—grow easily from seed that is collected from splitting seed capsules.

Rub the seeds together to break up the papery wing attached to each seed. Sow the seed on a normal seedling mix. It germinates within about ten days. Grow the plants on in a well-drained, humus-rich soil. All these plants are creepers and need enough room to grow and a mini-trellis to clamber over. Without support, the creeping stems intertwine, making it very difficult to separate the plants to re-pot them or plant them back into the wild. Since *Dioscorea* develops an underground caudex, allow the plant to rest during its dormant season. General use of plant nutrients allows these plants to grow very rapidly. Finally, *Dioscorea*, which is dioecious, should be planted in groups of a minimum of five to ensure at least one female plant (Hurter, 2002 & 2003).



▲ **top left** Dichapetalum cymosum *fruit. (Photo: Christo Botha);* **bottom left** *A 4-year-old* Dioscorea sylvatica *plant in cultivation in Durban. Note the tortoise shell-like appearance of the caudex, hence the Zulu name of* ufudu*—tortoise;* **right** *Seed capsules of* Dioscorea sylvatica *showing the three-chambered capsule.*

▲ Diospyros natalensis *seedling showing narrow Ebenaceae cotyledon.*

EBENACEAE
Ebony family

The two genera that are mentioned in the lists are *Diospyros* and *Euclea*. As hardwoods and slow growers, both are difficult to root from tips or semi-hardwood cuttings. Propagation from seed is the most successful method.

Fresh seed is best. If it is necessary to use stored seed, I suggest nicking the end of the testa to allow water into the seed before sowing it on seedling mix. This family is dioecious, and at least five specimens of each species should be planted to be sure of a female plant.

The seed of *Diospyros whyteana* seems to be difficult to germinate. I have observed other growers using diluted hydrogen peroxide and even sulphuric acid in the hope that with this treatment it will be possible for water to enter the seed. I don't know whether these methods have proven successful or not.

WARNING

The *Diospyros villosa* seed capsule has fine hairs on the outside that can cause intense irritation if they get into the soft skin on one's hands and between fingers. Use leather gloves to split these capsules and a pair of pliers to prise the segments apart.

I have been able to germinate *Diospyros inhacaensis, D. dicrophylla, D. simii*, and *D. natalensis* successfully, provided they were sown fresh.

The dune-dwelling *Diospyros rotundifolia* germinates from seed, but has to be grown in the dunes to survive. Seedlings do not like living in packets or containers, nor in normal soil.

Euclea has a fleshy fruit, containing a hard testa that protects the seed. Collect seed that is produced in profusion by female plants in a population. Also, collect seed from as many individuals as possible. Female trees will not produce seed every year, making it important to collect seed whenever the opportunity presents itself. Clean off the flesh and crack the seed coat to ensure that water can reach the cotyledons. *Euclea* seed germinates

▲ **top** Diospyros villosa *fruit showing hairs;* **bottom** Euclea racemosa *seedlings. Note the narrow cotyledon.*

within about 3 weeks, but the plants do not like living in captivity. Plant them out.

Exercise some patience when dealing with these plants!

ERICACEAE
Heath family

This group of plants can be propagated from both seed and cuttings, and smoke treatment improves germination rates.

See more in Chapter 2 under Smoke treatment and Chapter 5 under Fynbos plants.

ERIOSPERMACEAE

The genus *Eriospermum* is well known for its significance in traditional medicine. All the species I know have an underground tuber, which may be branched or unbranched. The tubers are used for medicine. I have been able to propagate these plants by division, splitting

▲ Eriospermum *seed head showing the hairy seeds.*

off pieces of the tuber just before spring while the plant is still resting. Flowers appear first, followed by leaves just as the seed is ripening. The seeds are covered in fine hairs that aid dispersal.

Seed germinates well if sown fresh. Sow in a tray and cover lightly with sand to hold the seed in place. Germination takes 7–14 days to germinate, depending on soil temperature.

These plants like to be root-bound in small, shallow containers. The best results are obtained when planted in 150 mm diameter plastic sleeves, folded down to provide a soil depth of about 100 mm. The tubers fill the sleeve and after a season or two start pushing bulges out of the black plastic sleeve.

TIP

When a plant starts to bulge or push out its growing bag it is time to plant it out.

EUPHORBIACEAE
Spurge family

The succulent species of *Euphorbia* and *Jatropha*, as well as *Synadenium cupulare* and *Monadenium lugardiae*, are relatively easy to grow if they are kept within their habitat preference.

Seed is the best way of propagation. The general principles regarding seed propagation apply. Euphorbias generally have hard capsules, within which, once mature and dried out, a tension is created causing an explosion that scatters the seeds away from the parent plant. Collecting *Euphorbia* seed is best done by picking the ripe fruit. This process can be tricky, given the sharp spines and corrosive latex that can cause severe irritation, should it encounter one's eyes.

WARNING

Wear protective goggles and leather gloves while collecting Euphorbiaceae seed.

▼ *A colony of* Monadenium lugardiae *growing in the Skukuza Nursery in the Kruger National Park. (Photo: Llewellyn Foxcroft.)*

Once the capsules have been collected, place them in a paper or cloth bag. Leave the bag in a dry, warm place to dry out. The bags will seem to come alive when the seeds are ripe and start exploding! When all the seeds have been set free, file the seed coat a little and sow it in a tray of seedling medium. Seeds should germinate after about 14 days, if the weather is warm.

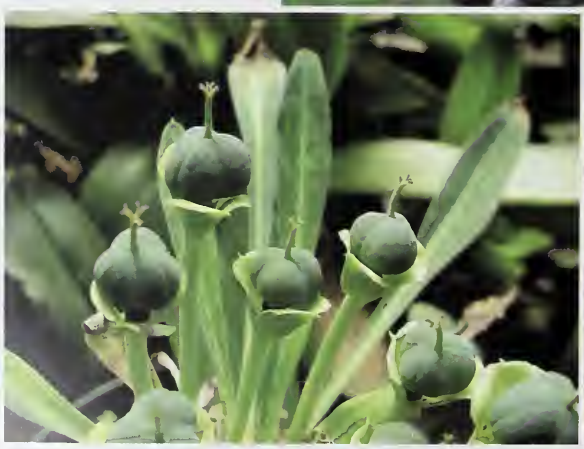
These plants are also propagated from cuttings and by division. I've had greater success with large cuttings or truncheons with a diameter of more than 40 mm. It is best to allow the cut stem to dry out for a week or so before placing it into the rooting medium, which should consist of sharp river sand. *Euphorbia* truncheons do better in the spring and summer when the plants are actively growing.

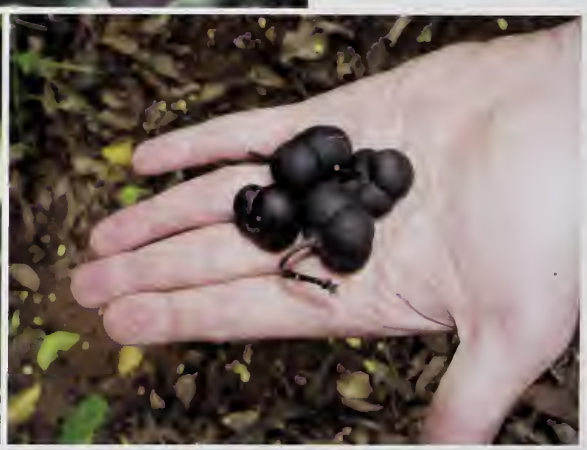
Keep the cuttings in a well-lit and well-ventilated environment. Be careful not to overwater the cuttings, as the stems will rot quickly if they remain damp.

WARNING

Do not rub your eyes after handling any Euphorbiaceae if you haven't washed your hands. The milky sap or latex of these species is highly corrosive.

If the seed from the trees of this family is sown fresh, it should germinate easily. Trees include *Cleistanthus*, *Bridelia*, *Sapium*, *Cavacoa*, *Croton*, and *Margaritaria*. Old seed is much more difficult to germinate.





▲ **top** Monadenium lugardiae *flowering shoot;* **bottom left** Euphorbia bupleurifolia *female;* **bottom right** Cavacoa aurea *fruit.*

FABACEAE
Legume or pea family

Seed of the legumes can be tricky to germinate, but generally, the best results are achieved when the harder-coated seeds are soaked and/or sandpapered. I use rough emery or sandpaper to scarify these seeds and in some cases have resorted to a heavy file, and for *Entada rheedei*, a mechanical grindstone. However, this last method requires the use of pliers or a vice grip to hold the seed steady. Grind the seed until the cotyledon within is just barely exposed. Do not cut too deeply into the seed; this invites pathogens to attack the seed before it even germinates.

It is best to sow the seed of the special, sandloving species, such as *Pterocarpus* and *Brachystegia*, while still fresh.

Follow a growing regime that takes the seasons into account; the plants should be kept relatively dry in the dry season, while watering and feeding should be stepped up in the wet season. This regime applies to container plants only.

Once the plants are planted out into open ground, they will usually look after themselves as long as livestock do not strip bark or too much foliage from the plants.

Cordyla africana is one of the few trees belonging to this family that produces fleshy seed. Sow the seed immediately after the flesh has been cleaned off. Germination takes place within days. The large seeds, with a diameter of 20–30 mm, lift the soil.

Some species, such as *Albizia* and *Erythrina*, grow from truncheons if these are taken at the end of the dormant season, just before the start of the new growing season.

▲ Combretum zeyheri *and* Pterocarpus angolensis *seed waiting for rain.*
▼ Brachystegia *seedling.*

Flacourtiaceae
Kei apple family

Seed propagation has achieved indifferent results. The principle of clean, fresh seed is important in raising success rates. *Scolopia* seed germinates, but only erratically. Species such as *Flacourtia*, *Xylotheca*, and *Rawsonia* all grow easily, but develop slowly. Inoculate soils in containers. Plant out the seedlings as soon as possible, as they don't seem to grow well in containers.

Homalium seedlings have smaller leaves than the parent trees, so they look a bit different. Seedlings grow well if seed is sown fresh.

Gentianaceae
Gentian family

I am not very familiar with this family, other than the genus *Chironia*. Seed is best sown in spring for the summer-rainfall species and in autumn for the winter-rainfall species. It is important to distinguish the annuals from the perennials when collecting seed. *Sebaea*, is an annual and *Chironia* is a perennial. Many of the members of this family prefer damp areas, such as seeps and wetland edges. Keep this in mind when attempting to grow these plants.

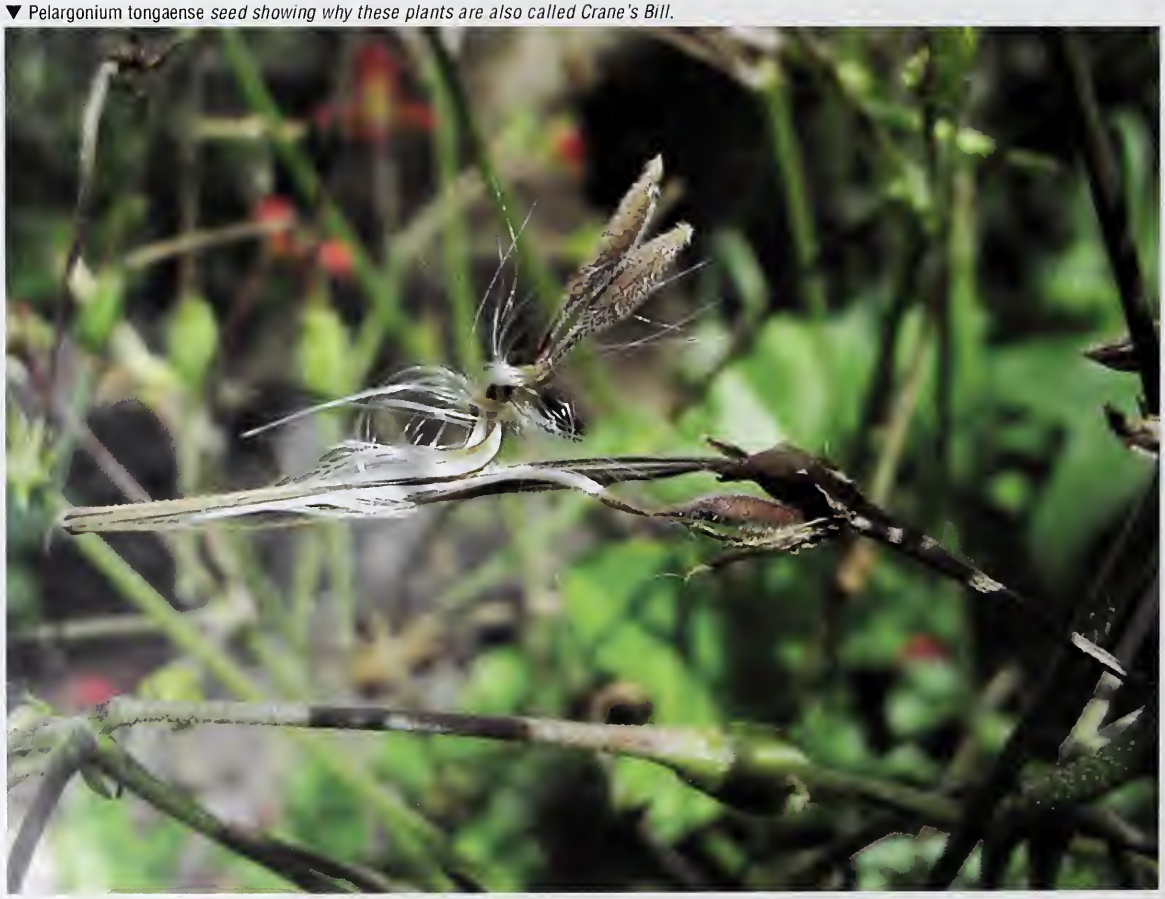
Sima Eliovson (1980) notes in her book on South African plants that the perennial *Chironia* species can be propagated from cuttings.

▲ Rawsonia lucida *fruit showing seeds in flesh, which needs to be removed before sowing.*

Geraniaceae
Geranium family

The geranium family can be grown from cuttings as well as seed. Take cuttings at the beginning of the growing season, when the sap starts to rise. In the case of the desert-dwelling species, imitate the natural life cycle conditions to ensure successful cultivation in captivity. Use some of the soil from the original habitat to inoculate

▼ Pelargonium tongaense *seed showing why these plants are also called Crane's Bill.*



the potting soil. The best cutting material is semi-hardwood from the previous season's growth.

Propagation from seed is relatively easy. Use normal seedling mix and transfer seedlings into well-drained, humus-rich soil. Once sown, seed takes about 7–10 days to germinate.

Red spider mite attacks this family in cultivation. Many of the species are succulent and appropriate watering regimes should be used. Do not mix collections, but rather place plants in the right growing zone of a glasshouse to have better control over winter versus summer-rainfall plants and disease. All these requirements demand a highly skilled grower to maintain the collection.

GESNERIACEAE
African violet family

Our indigenous *Streptocarpus* species have a seed capsule that consists of a series of longish strips, twisted together to form a hollow cylinder, which contains fine seeds. As the cylinder dries out, it untwists and releases the seed into the atmosphere. When it gets wet again (after drying out), it re-opens and releases seed into the film of water that surrounds the capsule. Many species occur commonly in southern Africa, while others are highly localised and found only in one or two localities in the world.

If sown fresh, *Streptocarpus* seed will germinate in 10–14 days. Older seed can take up to a month to germinate. It is of great importance to keep the seed moist, warm, and exposed to light to induce germination. A high light intensity tends to keep fungal spores at bay, but once the seed has germinated, the light should be reduced somewhat to prevent sunburn. It is a case of finding out through trial and error, as each region in the country has slightly different conditions, requiring one to adapt accordingly. This is the critical stage when fungal diseases, attracted by the humid, warm, and moist conditions, attack the seedlings. Treat seedlings proactively with a good drench of fungicide over the soil and the seed—prevention is better than cure.

▲ **top** Streptocarpus *seed capsule;* **bottom left** Streptocarpus sylvaticus *on a tree trunk in Nkandla Forest;* **bottom right** Gunnera perpense *growing in its wetland habitat. Note the typical "shepherd's crook" or "hooked staff" shape of the inflorescence.*

For details on sowing fine seed, see Fine Seed in Chapter 2. Also, see the vegetative reproduction section for leaf cuttings in Chapter 3. For more information, you can consult Van der Walt (2001) and Kendle & Lloyd-Bostock (2000).

GUNNERACEAE
Gunnera family

The River Pumpkin (*Gunnera perpense*) is overutilised for its medicinal properties. The rhizomes of this plant are used in both bovine and human obstetrics to remove a persistent placenta after birth.

Use the rhizomes to propagate these plants by breaking or cutting off pieces of at least 150 mm long. Lay these in damp river sand until the new shoot and roots develop. As a wetland species, it needs boggy soil in which to grow. The trough, as discussed under Cyperaceae, is ideal for growing *Gunnera*. It has horticultural potential, but does not reach the huge proportions of *Gunnera manicata*, which hails from China.

▲ **top left** *This* Trichocladus grandiflorus *seed capsule is full-size but unripe;* **top right** Salacia gerrardii *and* Calodendrum capense *seed dropped by feeding Samango monkeys onto the forest floor;* **bottom left** Salacia kraussii *seeds and fruits—palatable survival food;* **bottom right** Hippocratea indica *flower, Lake Malawi.*

Hamamelidaceae
Witch hazel family

The witch hazel family is relatively easy to grow from seed. I have grown *Trichocladus crinitus*, *T. ellipticus*, and *T. grandiflorus* from seed, and with the correct amount of dampness, warmth, and light, the seed germinates without exception in about 2–3 weeks in normal potting soil. However, the seed has to be collected at exactly the right time. I have a *Trichocladus grandiflorus* in a big container; it flowers in August each year and produces a few fruits, but I seldom see the seed as the fruit splits open to shed its seed very suddenly.

The best cuttings for all the species are soft tips taken in the spring and placed in a bottom-heated mistbed.

Hippocrateaceae

I have been able to grow *Salacia leptoclada* and *Salacia gerrardii* from seed, which takes about 2 weeks to germinate. Once collected, clean off the flesh that surrounds the seed before sowing. It would probably be easy to grow these creepers or scrambling shrubs from cuttings, but I haven't yet experimented with this method. I suspect that it would work best from a semi-hardwood cutting.

I have grown *Hippocratea africana* and *Hippocratea delagoensis* from seed. It takes about 10 days for seed to germinate if kept damp and warm in a tray of seedling mix, exposed to enough sunlight.

Hyacinthaceae
Hyacinth family

This is one of the easier families to propagate. The threatened species are usually at risk because of overutilisation.

The genera in this family include *Albuca*, *Amphisiphon*, *Androsiphon*, *Bowiea*, *Daubenya*, *Dipcadi*, *Drimia*, *Eucomis*, *Hyacinthus*, *Lachenalia*, *Ledebouria*, *Litanthus*, *Massonia*, *Neopatersonia*, *Ornithogalum*, *Polyxena*, *Pseudogaltonia*, *Rhadamanthus*, *Schizobasis*, *Scilla*,

◀ Eucomis autumnalis *seed capsule.*
▶ **opposite** Hippocratea longipetiolata *seed with the outer half of the capsule split to show the winged seed.*

Tenicroa, *Thuranthos*, *Urginea*, *Veltheimia*, and *Whiteheadia* (Perry, 1985).

I have found that leaf bases of *Eucomis autumnalis* root and produce bulbils from the base of the cut leaf in a mistbed. This is slow, but does work if one is dealing with only one self-sterile plant.

Another genus that produces bulblets from leaf bases is *Lachenalia*—cut off the upper half of the leaf and place the lower half into damp sand.

See the detail of both vegetative and sexual reproduction under the Bulb and Corm section in Chapter 3.

▲ **top** Eucomis autumnalis *leaf cuttings;* **bottom** Bowiea volubilis *seedlings.*

▼ Bowiea volubilis *seed capsules. The above-ground parts of* Bowiea volubilis *are inflorescences, which twine around trees in the wild. Propagation from seed works well and under optimum conditions the plants will flower in the second growing season.*

Hypoxidaceae
Hypoxis family

The best way of propagating this group is from seed. Tissue culture has been successful in increasing numbers, but this is an expensive and impractical method for general propagation, except in the case where a certain clone is selected.

High-altitude species may have to undergo a period of cool storage, but these plants flower so early in the season that seed may have time to germinate before the winter resting time. Store seed in a cool, dry place. Once the last frost has passed and spring arrives, sow the seeds in the usual seedling mix.

The winter rainfall genera of *Spiloxene* and *Empodium* need to be sown during autumn and treated like any other winter rainfall bulb.

For more information, see du Plessis & Duncan (1998) and Hawker *et al.* (1999).

Icacinaceae
White pear family

I have been able to grow *Pyrenacantha scandens* and *P. grandifolia* from seed. Collect the seed when the fruit is ripe (when the flesh has turned yellow). Clean the seed and sow immediately. The plants are slow to establish, but grow well once planted out in the open ground.

To cultivate these plants successfully, plant at least five specimens to ensure that at least one is a female.

Iridaceae
Iris family

The irids are relatively easy to grow. Peter Goldblatt commented on woody irids like *Witsenia* and *Nivenia* in an article that he wrote for *Veld & Flora* in December 1992. According to Peter, these genera grow reasonably well from seed, but do not transplant well.

Iridaceae can also be propagated by dividing the corms, but seed is always the most successful method of increasing plant numbers.

See the bulb section in Chapter 3 for more information. Du Plessis & Duncan (1998) provide additional details.

Kirkiaceae
Tree-of-heaven family

In my experience, *Kirkia acuminata* and *K. wilmsii* grow well from seed, which germinates within a couple of weeks. *Kirkia dewinteri* should also be simple to grow, provided you collect the fresh, papery-textured seed.

I assume *K. dewinteri* will also root from truncheons. Take the truncheons just before the end of the dry season when rains are expected. Place the truncheon in a hole as deep as a third of the length of the branch in the garden. These branches should send out new shoots within a month and after the first growing season, the plant should be established. Water the new tree once a week as soon as it is evident that the new shoots are actively growing during the summer or growing season.

▲ **top** *Unripe* Pyrenacantha kaurabassana *fruit;* **bottom** *Ripe* Pyrenacantha kaurabassana *fruit.*

TIP

Use a saw to cut the truncheons from the parent plant. I always clean off the end of the severed branch with a sharp knife, removing any torn and bruised stem, to enable the new roots to develop from clean, healthy tissue.

▲ Thorncroftia longiflora *flower, showing the long flower tube that gives this plant its specific name.*
▼ Thorncroftia longiflora *in Swaziland and north-eastern South Africa.*

LAMIACEAE
Mint family

This family has huge horticultural potential and is relatively easy to cultivate. Propagation from cuttings or seed should be undertaken during spring or early summer for the summer-rainfall species and in autumn for the winter-rainfall species.

Clerodendrum (previously in Verbenaceae) seed has to be cleaned and sown within hours. Keep in mind that seeds of fleshy-fruited plants lose their viability quickly when they are allowed to dry out. Semi-hardwood cuttings of the previous season's growth work well. Treat the cuttings with a rooting hormone, such as Seradix 2, and keep the soil or growth medium warm. They will root within 3 weeks.

Cuttings from *Orthosiphon* can be tricky to root—the best results are achieved from soft-tip to semi-mature woody cuttings. Root these in a mistbed with bottom heating. I find that *Stachys* has to be treated in the same way. Prune the woodier *Orthosiphon* and *Stachys* plants in the dormant season to ensure good cutting material at the start of the growing season. The new shoots that appear in the spring grow vigorously and make excellent cuttings. Cuttings should not be taken when plants have already started sending up flower buds, or when plants have finished flowering.

Hemizygia should be grown in cooler areas or at an altitude that is characteristic of their natural habitat;

they do not survive on the humid coast of KwaZulu-Natal.

Propagation of *Plectranthus* is best achieved from soft-tip cuttings. They grow easily in sharp sand or normal garden soil, provided the moisture and humidity levels are kept up. The succulent species prefer sunny positions and grow prolifically from cuttings and seed.

I have grown *Thorncroftia* from seed and cuttings, but these species prefer to be grown in their own habitat or climatic zones. A more temperate climate with cool evenings and altitude are essential to ensure the successful propagation of this genus. It takes a couple of weeks for cuttings to root and they are ready to be potted on within a month. They thrive in sunny, well-ventilated places with plenty of leaf litter, in a well-drained soil, in between rocks on sloping ground.

The tuberous *Plectranthus* species, including *P. oribiensis* and *P. esculentus,* need a winter resting period with no water. They are prone to eelworm damage, so make new cuttings each season to keep the pests at bay. *Plectranthus oertandahlii* grows well from seed, but if you have a good form with silver leaves, make cuttings to retain its characteristics.

Solenostemon also needs a proper resting period with no water; otherwise the tubers will rot away. These tuberous species will grow from divided tubers as well as from cuttings of vigorously growing shoots.

LAURACEAE
Laurel family

In my experience, this family is best propagated from seed. *Ocotea bullata* seed is best cleaned and sown on the same day. The outer flesh of the seed has a clean, crisp smell and stains one's fingers a dark orange colour, a bit like the hands of a smoker with heavy nicotine stains. Seed germinates in 30 days with bottom heat. On the KwaZulu-Natal coast, seed sown in mid-winter, during June, only germinates with the help of bottom heat. Without the heat, the seeds do not germinate well and most succumb to fungus attack.

Margaret Thomas from Kirstenbosch has grown cuttings of *Ocotea bullata* in a mistbed. In her experience, cuttings root in 3–4 months and mid-May is the best time for making them. Margaret uses IBA at a concentration of 4,000 parts per million, or Seradix 3 for the semi-hardwood cuttings. These have proven more successful than soft-tip cuttings. We have also found that semi-hardwood cuttings strike better, but making them is time-consuming (Phillips, 1924; Thomas, 1992). We found that soft tips cuttings work best in late August, just as the new flush of leaves appear. We are fortunate in that we have a few stake-out trees that provide the bulk of our annual quantity of seed.

I am sure that the seed and cuttings of *Ocotea kenyensis* will respond to these treatments. It is always advisable to find and map stake-out trees of these forest species, as human memory is short and finding a single tree in a forest of trees could be like looking for the proverbial needle in a haystack. With the help of GPS technology, mapping trees for future workers in this field should be a simple task.

LOBELIACEAE
Lobelia family

This family has a range of sizes that can cause some confusion. There are the giants, found in the high, mountainous areas of East and Central Africa, such as *Lobelia gibberoa* and *L. stricklandae*, and there is the tiny *L. anceps*, which occurs on wetland edges.

The large species grow from offsets or suckers that originate from the parent plant. Making cuttings of these large species is often a problem because of the cladding of hairs and bracts around stems. For the smaller, more conventional species, make cuttings in the spring or beginning of the rainy season.

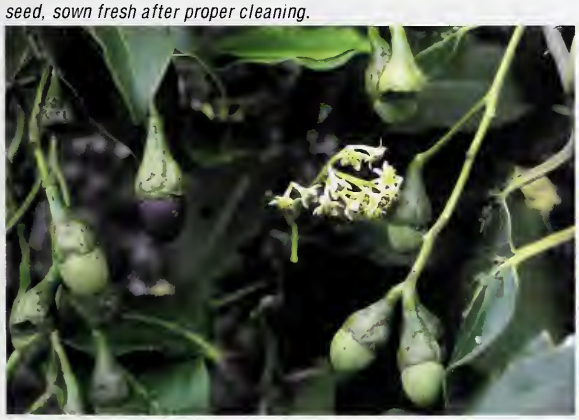
The damp-loving species seem to grow more successfully from soft-tip cuttings. Watch a population of plants and use a gardener's diary to make a note of the time when the plants are in seed.

TIP

Collect the fine seeds at the beginning of the new season and sow, mixed with some fine sand for an even spread over the tray.

In cooler areas, seed can be sown and kept in a glasshouse until the last frost has passed before placing it outdoors.

▼ **left** Ocotea bullata *fruits and flowers;* **right** Cryptocarya myrtifolia *fruit. I have successfully propagated members of the genus* Cryptocarya *from seed, sown fresh after proper cleaning.*



Seed needs ample light and moisture in well-drained soil. It takes 14–21 days to germinate. In an attempt to cultivate these plants, imitate the conditions of their natural habitat.

LOGANIACEAE
Buddleja family

The genus *Strychnos* is best propagated from seed. *S. madagascarensis*, *S. spinosa*, and *S. gerrardii* produce huge woody fruits resembling oranges. The smaller-fruited species, such as *S. usambarensis*, *S. henningsii*, and *S. decussata*, have a softer outer covering to the fruit.

Collect enough seed to have a good supply for at least two seasons, because the smaller-fruited trees do not fruit each season. The seed of both the large and smaller-fruited species is individually wrapped in flesh that needs to be removed before the seed can be sown.

▲ Strychnos gerrardii *fruit and seeds ready for action.*

TIP

Rub off the flesh with a mixture of sharp river sand and a little water. This grinding paste abrades the flesh and scratches the seed coat, aiding germination.

Seed germinates within about 3 weeks. All the species that I have grown, including *Strychnos gerrardii*, *S. usambarensis*, *S. madagascariensis*, *S. spinosa*, *S. mitis*, *S. henningsii*, and *S. decussata* germinate readily, but grow slowly in containers. Plant the seedlings out and observe how growth speeds up when long, soft shoots are pushed out each season. As the season progresses these shoots fill out.

Nuxia and *Buddleja* both have fine seeds that germinate well, if somewhat irregularly over time (Steel, 1989).

Buddleja, in particular the scrambling species, *B. pulchella* and *B. dysophylla*, grow easily from cuttings. This is a good way to ensure that you retain the characteristics of the plant, like flower colour or plant shape. Take cuttings at the beginning of spring or the new growing season. *B. salviifolia* is propagated more successfully from soft-tip cuttings.

LORANTHACEAE. SEE VISCACEAE.

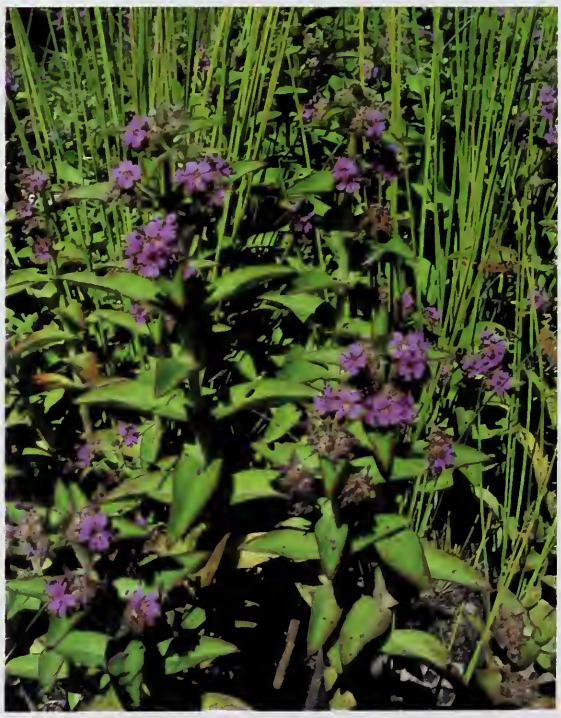
LYTHRACEAE
Loosestrife family

Common sense tells me that these plants love to grow in marshy or wet areas. The genus *Nesaea* is simple to grow from seed and I suspect that these plants are more common than we realise. Botanists generally don't like to get their feet wet. This is made worse when moving further north in Africa where the creatures that consider humans as prey tend to lurk in the murky waters of marshes, pans, and floodplains.

The best way to cultivate these plants is to sow seed in a seed tray. Leave the tray partially submerged in a pan or tray of water to ensure that the soil remains wet. Seed germinates quickly and can be pricked out into individual pots or containers to grow to their full size. I know a nursery where *Nesaea* is like a weed, shedding its fine seed in all the pots that contain other wetland species.

NOTE

Once in the pots or containers the plants will wilt and wither if allowed to dry out. They will grow again, but it does take a toll.



▲ Nesaea radicans.

Propagation from cuttings has also proven successful. Break off a piece of semi-mature stem in the growing season and plant it in sharp river sand. It will root in about 14 days.

These plants will root from cuttings and the seed will germinate if allowed to settle on a sandy substrate.

The best way to go about seed propagation is to watch these plants closely until they are ready to shed their seed. Should it be impossible to wait for the seed to reach this stage of readiness, for instance, when you are on a collecting trip and pressed for time, collect a couple of plants, pack them in a plastic bag and grow them in a damp area in your botanical garden until the seed is ready to be shed. You will have a new population of these plants in no time!

Rotala *are water-edge plants but will also live in water, for example,* Rotala myriophylloides *floats just below the water's surface with the flowers and a few leaves just above the water.*
—Rene Glen

MALPIGHIACEAE

The actual propagation of this family is quite simple, but collecting seed isn't. It is a matter of collecting the seed when it is ripe, but not yet parasitised. The fruit of *Acridocarpus* is highly parasitised. Open each winged fruit and remove the seed within to prevent the seed predators from damaging it.

▲ **top** *Winged fruit of* Acridocarpus natalitius, *showing why it is also called Moth Fruit;* **bottom left** *With its yellow flowers, the* Sphedamnocarpus pruriens *creeper is a very attractive plant;* **bottom right** *The winged fruits appear in late summer.*

▲ *Seed capsules of* Hibiscus tiliaceus *that are splitting and shedding their seed.*
▼ *Young seedlings of* Hibiscus tiliaceus *growing in a seed tray. These seedlings are ready for pricking out into their individual pots.*

The testa of the seed should be cleaned well and sown fresh. Seed takes about 3 weeks to germinate for both *Sphedamnocarpus* and *Acridocarpus* (Douwes *et al.*, 2001; Van Wyk *et al.*, 1982).

Sphedamnocarpus and *Acridocarpus* are propagated successfully from semi-hardwood cuttings at the beginning of the growing season. *Acridocarpus* roots will shoot after they have been damaged.

Triaspis is a very attractive genus of scrambling plants. I have seen this plant only in the far northern bushveld regions of South Africa. I suspect that the plant is overlooked; its seed is not collected and grown because of the low human population density characteristic of its habitat.

MALVACEAE
Hibiscus family

The Hibiscus family is another relatively easy group to propagate from seed. Some species are also grown successfully from semi-hardwood cuttings.

Collect seed as the capsules start to split open. In South Africa, these capsules are prone to parasites, such as Cotton Stainers (*Dysdercus intermedius*). If they are a problem in your area, prevent the fruits from being reached by the insects with their long probosces—shield the fruit with a supported insect-proof gauze.

Hibiscus tiliaceus can be propagated from cuttings and truncheons, taken as the growing season starts. I find that a mistbed works well for the more shrubby, softer species.

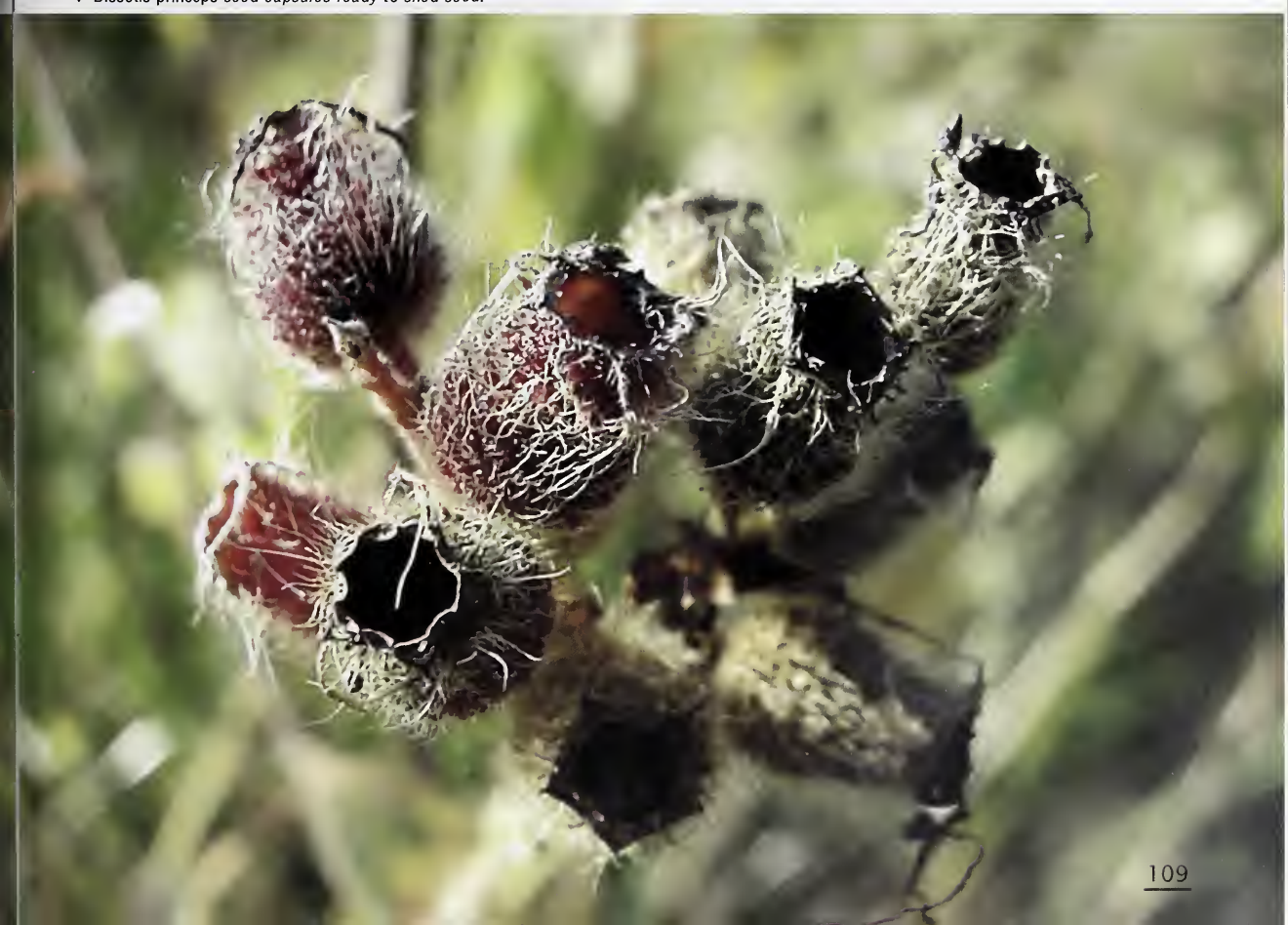
MELASTOMATACEAE
Meadow beauty family

The best method of propagation for *Dissotis* is from seed. The seed is fine and should be collected just as the capsules begin to split. Let the capsules disgorge their seeds into a paper bag. Once the seed is released from the capsules, sow it into a tray of seedling mix and treat it like any other fine seed. Germinate and grow these plants in full sun. The fact that *Dissotis* grows along seepage lines and wetlands should serve as an indication of the conditions needed when growing them *ex situ*. A planting theme for this type of habitat could be developed in the garden.

In David Styles's experience, *Memecylon* seed should be collected only when the fruits are ripe—when they have changed colour from green to black. The fruit does seem to take forever to ripen and bunches of green fruit are a familiar sight. When ripe seed is collected, remove the flesh and sow it fresh. Set the seed just below the surface of the sand and use a fine-nozzled rose to keep it damp. Do not drench the sand.

Another propagation method that has proved successful in the case of *Memecylon* is hardwood cuttings taken in the spring.

▼ Dissotis princeps *seed capsules ready to shed seed.*



Meliaceae
Mahogany family

This whole family is best grown from seed. The recalcitrant seeds of *Turraea*, *Trichilia*, and *Pseudobersama* germinate well. Clean off the aril and sow immediately on a seedling mix. Grow the seed in a warm area with enough water, but make sure that it doesn't become waterlogged.

Khaya and *Entandrophragma* have dry, winged seed that can be stored for a while until the start of the new growing season, when the seed germinates within about 14–21 days from sowing.

While *Entandrophragma* seeds germinate quickly, the young plants sit for quite a while, developing their roots while not showing much shoot growth. Grow *Entandrophragma* in a well-drained, sandy soil.

I learnt from Werner Voigt at the Karoo Desert Garden to use bark and polystyrene balls as a seedling mix to grow *Nymania capensis*. The polystyrene helps to keep the soil warm and encourages root growth. Move the seedlings as soon as possible after germination into their final growing site, so that the plant can establish itself before the roots become too developed for the container. Keep the roots damp to prevent them from drying out when the seedlings are transplanted into the garden.

Menispermaceae
Moonseed family

Just when I think I know it all, along comes a plant that I do not know, bringing me down to earth. *Dioscoreophyllum cumminsii* from Zimbabwe is just such a plant. Judging by the successful propagation of its first cousins, the genera *Cissampelos* and *Tinospora*, *Dioscoreophyllum cumminsii* should grow well from seed.

Collect the seed, usually surrounded by an orange-coloured, fleshy pericarp. Clean off the flesh and sow the seed on normal seedling mix. Seedlings should be popping up within 10–14 days. Propagation from cuttings also works well for *Cissampelos* and *Tinospora*. Take cuttings from the last season's growth and place them in sand in a mistbed. There should be enough roots to transfer the plant within 6 weeks.

Tinospora represents the more adventurous climbers and strong survivors of the plant world. These plants are semi-succulents and make very interesting container plants. They grow in coastal forests and propagate from roots that appear out of the forest canopy and grow down to the forest floor where they take root and thicken into a warty, lumpy stem of about 5–10 mm in diameter, forming a liana. To propagate a *Tinospora* plant, suspend the stem about a metre or so over a pot or tray filled with soil that is kept damp. The root will shoot from the stem and grow down into the soil, the way it does in its natural habitat (Van Jaarsveld, 1981).

▲ **top** Entandrophragma caudatum *seed capsule. (Photo: Llewellyn Foxcroft);* **middle** *Winged seed of* Entandrophragma caudatum; **bottom** Tinospora caffra *fruit ready to harvest.*

MESEMBRYANTHEMACEAE
Vygie family

Lithops and *Conophytum* have very specific growing needs. During the dormant (non-growing) season, they have to be kept dry and will not survive cultivation under the humid, subtropical conditions of the coast, but will thrive in a winter-rainfall area where summers are hot and dry.

Anthony Hitchcock recommends a fine sieved mixture of the "adult" mix for sowing *Conophytum* and *Lithops* seeds, covered in a 2 mm layer of grit or gravel, so that the sand holds the seeds in place. Rather have more trays with fewer seeds in each, than a few trays containing many seeds. This will help prevent fungus. Should one tray become infected, there is still a good chance that other trays will produce seedlings. The use of a pre-emergence fungicide on fine seed is often a good idea, as this keeps the fungus at bay before the seeds germinate.

Conophytum needs water in winter, rather than summer, as they come from winter-rainfall regions. Steve Hammer refers to Tischer, who was the first to notice that they respond to a richer, more humic soil, similar to that which is favoured by *Lithops*.

The following formula is recommended: 1 part heath soil or leaf mould : 1 part unwashed sand: 1 part clay.

Lithops like to grow with their bodies below ground level so that only the "window" shows. When watering, the plants will rise slightly above ground level. Do not continue watering. Most *Lithops* come from the summer-rainfall area, but there are a few from the winter-rainfall area. This needs to be kept in mind. Plants such as *Gibbeaum* or *Argyroderma* literally explode when given too much water. *Lithops* with too much water or humidity in the atmosphere, burst open, often with fatal results.

Much of what he says applies to other succulent groups. Shrubby forms root easily from cuttings.

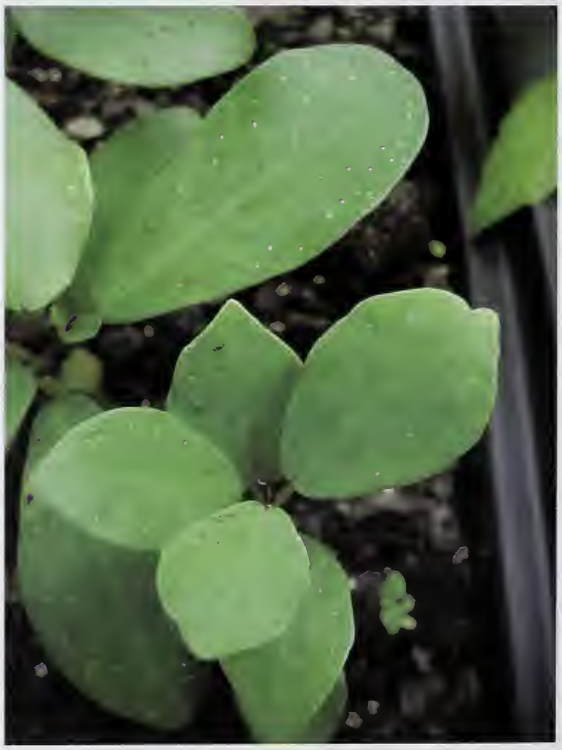
▲ Lithops *seedlings in cultivation.*

It is one thing to raise the plants reasonably well, quite another to raise them superbly, and a fine sphaeroculturalist must reconcile opposite principles: caution, and a constant willingness to experiment. It involves an appreciation of the annual cycle—when a Conophytum wants to rest or grow, it will let one know. Fortunately, Conophytums love life in a pot. In a sense, they are pre-adapted to confinement, coming as they do from cramped habitats. However, the way plants grow in a pot has only a tangential, or at most a partial, relation to their exact ambience in the field. The fact that most Conophytums seek out shade in habitat is directly relevant. The need for dew or fog is also relevant.
—Steve Hammer

See Succulents section in Chapter 5 for more information.

▲ **left** Lithops fulviceps *in cultivation;* **right** Conophytum *in cultivation.*

▲ Ficus natalensis *fruit.*
▼ Ficus natalensis *seedlings showing white dots on leaves.*



MORACEAE
Fig family

Seed

To collect seed of Moraceae, find trees that are in fruit and make sure that the fruit is ripe—the syconium must be soft to the touch. Pick ripe figs or collect those that have fallen to the ground. Split the figs open to expose the seed and place them in the shade to dry out for about one day. Grind the drying figs gently between your fingers. Spread this crushed fig mixture on the surface of the damp growing medium. Some growers sieve out the dried pulp to separate the seeds. I do not do this as the pulp helps to keep moisture around the seeds.

WARNING

Moisture does create the risk of fungi attacking the germinating seeds, but I have never had a serious problem. Remember to place the trays of sown seed in a well-lit, preferably sunny, well-ventilated spot. This reduces the chances of an attack by fungi.

In my experience, the most successful medium for germinating figs is sharp, washed river sand, mixed thoroughly in equal proportions with vermiculite.

Once the seed is sown, spread a bit of this seedling mixture over the seeds, so that when they are watered the

▲ **left** Ficus polita *fruit on stem;* **right** Ficus sur *cluster figs.*

seeds don't float to the sides of the seedling tray. Use a watering can with a fine nozzle if water is applied from above. Some nurseries use bottom-watering techniques. I have found that the best trays to use are 60–70 mm deep, 300 mm long, and 200 mm wide.

Some growers cover their seed trays with a sheet of glass or clear plastic sheeting to keep the moisture and humidity levels high in the microclimate of the seedling tray.

Seed can be stored for longer periods, but viability is then reduced. Store fig seed in a cool, dry place in a paper packet or glass bottle. I often put seed in the bottom of my fridge for a couple of months. The right time to sow is in the early spring or at the beginning of the rainy season.

It is important to remember that the germination rates of figs vary considerably depending on how fresh the seed is when sown: the fresher the seed, the faster the germination. Heat also plays a role, as well as time of year—when the ambient temperature is low, the seed will take up to four weeks to germinate. Bottom heat from a heating cable is a good idea to stimulate seed to germinate. In cooler climates, heat gives the delicate young plants a boost to get ready for the potting-on stage.

Fig seedlings tend to look weak when they germinate. The cotyledons are not robust, but thin and smallish with an oval to round shape. They last for about one week, during which time the juvenile leaves appear, and the little plants start to grow rapidly. Feed these plants with a dilute solution of liquid fertiliser. I use a solution that is 50% weaker than the recommended solution, as stipulated by the manufacturer's label.

At this stage, the seedlings should be exposed to strong light conditions to prevent fungi from setting in and decimating the seedlings. I use Benlate or Captan fungicide as a soil drench. It works best if you use fungicide before the pathogens attack. Germinate most species in full sun to toughen up the young plants.

Juvenile figs have little white dots or spots around the edges of the leaves. As the plant matures, the spots seem to disappear. Seedling and coppice shoot leaves tend to be much larger than the normal mature leaves. Shape and texture play an important role in identifying our figs, but the leaf sizes are so variable that to use it as a key criterion in identifying the plant could get you into all sorts of taxonomic tangles!

Once beyond the young seedling stage, the plants grow rapidly in a sandy, humus-rich, well-drained soil. I start the young trees off in a small 500 ml black plastic packet or sleeve. As the roots start appearing out of the drainage holes at the bottom of the container, I pot them on to the next size container.

If you are a bonsai enthusiast, this is the time to begin training and shaping the roots of your future prize specimen. When the plants are young, the roots are vigorous and spread over a rock or new pot much more easily than if the tree has struggled in a container in a nursery for years.

Cuttings

Figs are generally easily grown from cuttings. Spring is a good time to strike cuttings—just as the new growing season starts and the sap is flowing. Softwood or semi-hardwood cuttings work the best for most species.

Local species take root in sharp, washed river sand in a warm spot. I sometimes hedge my bets by placing the tray or pot with the cuttings inside a clear plastic bag to ensure that the water loss is minimised and the relative humidity is kept high to reduce water loss through transpiration.

The cuttings take up to a month to root and are ready for potting on in about eight weeks.

Air layering is another way of establishing larger plants or plants that are difficult to root, as are hardwood cuttings and truncheoning.

Details of these propagation methods are discussed in Chapter 3.

It has to be emphasised that these methods should be the last resort if there are only a few plants of the fig that need to be propagated, because it is not a very efficient way to bulk up quantities of plants.

Ian Garland used truncheons of *Ficus trichopoda* in his campaign to re-establish swamp forests and wetlands in the sugarcane lands around Mtunzini on the KwaZulu-Natal North Coast. He placed the trunks or stems horizontally on the soil, along the contours of the slope. This holds the soil in place and slows down surface water run-

off. These stems started to push out shoots, initiating the cycle of healing by shading and protecting the waterways where water had previously been rapidly removed from the lands.

Transplanting

When planting your specimen into the open soil, a proper hole of approximately twice the size of the container should be prepared. Mix, by volume of the hole, one-third well-rotted compost, and a cup of superphosphate fertiliser with the soil from the hole. Refill the hole with the mixture and open up a cavity, similar to the size of the container with the fig. Take the plant out of the container or plastic bag, place it into the cavity, and tamp the soil down with your hands. Once the tree is firmed down and settled, water well to ensure that the capillary action necessary to carry water through the crevices in between the soil particles is restored. The watering drives the air out from around the roots and soil, which were disturbed and exposed during the planting process. Water regularly (weekly) for at least one season after planting.

Today, with the use of synthetic water-holding compounds that can be added to the soil, less watering is needed during the post-planting period. Good plant husbandry depends on the gardener or horticulturist visiting the newly planted tree on a regular basis.

Musaceae
Banana family

Ensete ventricosum seed needs to be scarified and cleaned, then laid between two wet gunny sacks or hessian sacks to germinate in a light, warm place. Lift one bag to check the seeds daily. Once the radicle appears, it is time to prick out the germinating seedlings into individual pots.

Myrtaceae
Myrtle family

This group grows slowly and seeds are markedly recalcitrant.

Semi-hardwood cuttings in a bottom-heated mistbed root easily after about a month to six weeks. I prefer not to use rooting hormones, but rather provide optimum conditions for rooting. If, however, there is some uncertainty, use Seradix 2 or one of the liquid preparations.

I spoke to David Styles, a local KwaZulu-Natal plant hunter who had this to say about growing *Eugenia*.

> *I have not tried to grow* Eugenia *from cuttings, but Ernst van Jaarsveld said they worked well when I talked about growing* E. simii. *Most* Eugenia *species grow well from seed, but the method depends on whether they have a thick or thin testa. Almost all the new or sandstone endemic species belong to the thick testa group. The testa is about 1 mm thick. I have always grown these thick testa species in pure river sand. The thick testa species include* E. verdoorniae, E. woodii *and three formally undescribed species from sandstone areas of Pondoland and the coastal escarpment of KwaZulu-Natal known for now only as* Eugenia. *sp. nov. A, B, and C.*
> *—David Styles*

▲ **top** Ficus sansibarica *syconium split to reveal seeds within;* **middle** Ficus natalensis *colonising a very inhospitable habitat;* **bottom** Ensete ventricosa *seed germinating in seedling bed.*

Professor A.E. van Wyk, who has taken the taxonomy and knowledge of this genus forward more than anyone else in South Africa, has determined that the grassland suffrutex *E. pusilla* also belongs to the thick testa group. This species was last collected in the Amsterdam area of Mpumalanga in 1912 and is presumed extinct.

With these thick testa species, one should remove all the flesh, leaving the woody testa exposed. Then remove the woody testa. Try to slice off the very top with a sharp, strong knife (you may need to press it in at first with some force to make the initial break). You should then peel the testa off. Some force is needed to break the testa, which is rigid and breaks into pieces.

WARNING

Be alert for when the testa suddenly breaks; fingers are easily cut.

Under the testa is the cotyledon, which is a pale, creamy yellow. Try to avoid damaging it, but this is easier said than done, as one tends to nick the cotyledon. However, small nicks do not seem to affect germination. A certain percentage of the thick testa species is parasitised by a small worm. Once the testa is completely removed, place the seed in damp, pure river sand (I have not tried other media, but this works well). Make sure that a bit of the creamy yellow cotyledon is exposed to light, but that most of it is underneath the soil surface.

The cotyledon will sit for many weeks as if nothing is happening. It will then start to turn green. When it develops a green complexion, the germination process has started. My advice would be to supply bottom heating to induce more rapid germination.

IMPORTANT

Sunlight is of great importance to seedlings with large, fleshy cotyledons. It enables the cotyledons to photosynthesise and produce energy for growing.

▲ Eugenia natalitia *seed cleaned and ready to sow.*

Another method of propagation is to scrape off a small piece of the testa to expose only a small piece of the creamy yellow cotyledon, and sow as described. These seem to take longer to germinate.

Once collected, the seed can be stored for a while—not for very long, but for a month or so. If fruits that have fallen to the ground do not germinate soon afterwards, they rapidly become unviable. They start to disintegrate (in spite of the thick testa) within a few months. One should collect fruit from trees before it falls on the ground.

Of the rare species, those with a thin testa are *E. simii* and *E. umtamvunensis*. I have managed to germinate the thin testa species of *Eugenia*, as well as the genus *Syzygium*. Clean off the flesh around the seed, nick or crack the thin testa and sow the seed on a damp seedling mix. This mimics the layer of leaf litter under the parent tree, which is warmer and damper than the surrounding countryside. The two *Syzygium* species, *S. pondoense* and *S. legatii*, are endemics that grow successfully from seed if sown immediately.

◀ *The ripe fruit of* Syzygium legatii *ready for harvesting. It is endemic to KwaZulu-Natal and Swaziland quartzite ridges.*

Nyctaginaceae
Bougainvillea family

Propagation from seed works well for both *Boerhavia* and *Commicarpus*, provided the seed is sown as soon as it has been harvested. The *Boerhavia* plants are ruderal weeds and will grow virtually anywhere. *Commicarpus* thrives in dune bush edges. Seed grows in sandy, warm, humus-rich soil. *Commicarpus* can also be propagated from soft-tip cuttings early in the growing season before flower buds appear. I haven't attempted to grow *Boerhavia* from cuttings yet, but suggest layering the plant if the stems are running along the ground. Layering involves pegging a stem tightly to the ground and covering the stem with soil where a node is situated. If the plant does root, it will be at this contact point.

▲ *Cleaned seed of* Ochna barbosae *ready for sowing.*

Ochnaceae
Ochna family

This group of plants is simple to germinate. Collect ripe fruit, clean off the outer seed coat or covering and sow it as quickly as it takes you to read this sentence. The black outer coat of *Ochna* seed has an oily feel to it and stains one's fingers and hands a dark green colour when it is removed. Sow the seed in a tray on a heated seedling mix. Keep the seedling mixture damp to assist seed germination, which takes about 10 days, depending on the species. The greatest challenge is to get to the seed before the birds do. I find that visiting the trees just after dawn is the best time to collect.

Seedlings tend to grow slowly, but generally, the plants that grow in open ground are also slow. Plant seedlings where there is a lot of sunlight. Watch out for more rapidly growing species, which grow from seed delivered by birds via their droppings, as these can overshadow *Ochna*. Remove these species.

Oleaceae
Olive family

Olea, *Jasminum*, *Schrebera*, and *Chionanthus* are best grown from seed. Collect as many seeds as possible to be prepared for those years when the plants do not flower and set fruit, as this family has a habit of "masting". The *Olea* is a great exponent of this fruiting strategy. *Olea woodiana* plants only set seed every 3 years, but when

▶ **opposite** *The ripe fruit of* Jasminum multipartitum *ready to harvest.*
▼ Commicarpus africanus.

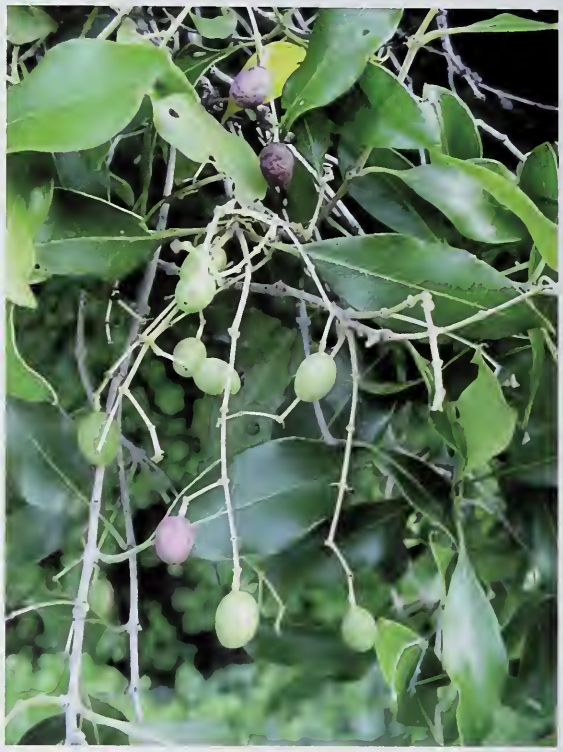
they do fruit, the whole tree is covered, providing a feast for birds and animals.

Clean the seed after it has been harvested and sow immediately. The extra seedlings, not needed immediately, can stay in the trays to be planted out at a later stage. If the fruiting period is missed, the seedlings that have germinated under the parent plants can be lifted and transferred into small bags.

I have not grown these plants from cuttings yet. There is a whole section on growing *Olea europea* from cuttings in Hartmann *et al.* (2002). Two types of cuttings are suggested, that is, hardwood from two- to three-year-old wood, and semi-hardwood from one-year-old, vigorously growing wood. Both types are best taken at the beginning of the growing season. These rules should apply for all the tree members of this family.

Experience and intuition are important factors in growing plants successfully. When you are not sure how to go about propagating a plant, do some homework and find another member of the same plant family that is propagated successfully. One should be able to use a similar method of vegetative propagation.

I tumbled upon the method of stem cuttings in the case of *Jasminum*. Stems of *Jasminum multipartitum*, *J. fluminense*, and *J. streptopus* root when they touch the ground. The stems start to sucker and these suckers can be removed and grown. This is a form of layering where the stem sends out new roots that begin to grow while still attached to the parent plant.



▲ Olea woodiana *fruit.*

ORCHIDACEAE
Orchid family

Orchids are plants that really attract humans and consequently are highly sought after. In Africa, orchids are used in traditional medicine, as food, and as ornamental plants. There is very little written about how long a grower is able to maintain an orchid plant in cultivation, let alone propagate captive plants. The epiphytes are relatively simple to propagate if you follow the rules of thumb, but terrestrial orchids aren't.

Terrestrial orchids

Terrestrial species are really quite difficult to grow unless you are a passionate orchid lover. This means that you must have seen the plants in the wild and be able to copy the wild growing conditions in a shade house or other type of growing structure.

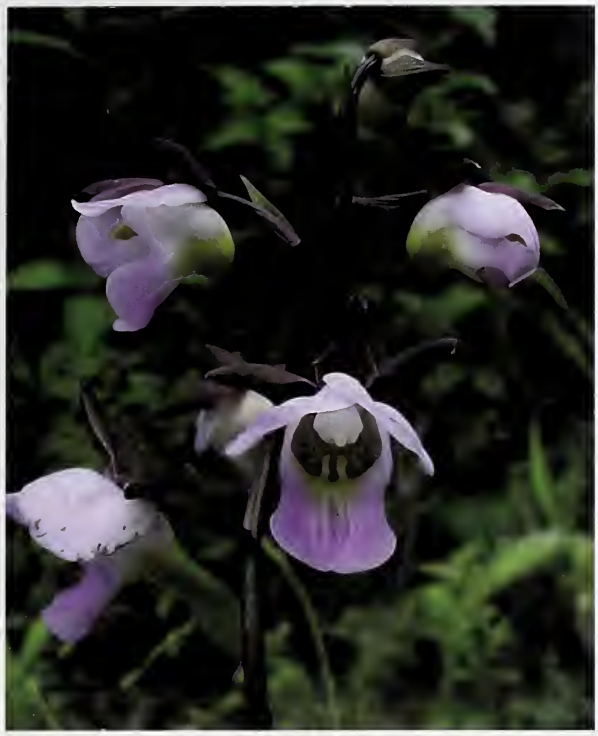
The trickier orchid species to propagate are those that grow in colonies in damp grasslands. The most difficult to grow in cultivation are the tuberous *Brachycorythis*, *Disa*, *Habenaria*, and *Satyrium*. These prefer to be grown in deeper containers or pots. The rhizomatous orchids that have more swollen stems at the soil surface, such as *Eulophia*, *Stenoglottis*, *Bonatea*, *Acrolophia*, and *Oeceoclades* are a little less finicky. These species prefer to be in shallow pans or trays to allow their roots to spread. A characteristic of terrestrial orchids that needs to be considered when attempting to grow them is that some are deciduous and others are evergreen.

I grow my shade-loving or forest terrestrial species in shallow trays in pure leaf litter with a layer of stones (5–10 mm deep) at the bottom of the container for additional drainage. Every year during the dry, dormant winter when the plants rest, I simply add new leaves to the tray. In the northern parts like Malawi, Zimbabwe, Zambia, and even Angola and Botswana, it is important to synchronise the regime for plants growing in cultivation with the seasons, allowing these plants to rest during the dry season, and take up an appropriate routine of watering and feeding in the growing season. My plants are without any water for 2–3 months, except for water from possible rainfall.

TIP

Choose a common species initially to serve as guinea pig and to get the propagation and cultivation techniques right before moving on to the more difficult and threatened species.

The first rule in this group, as in the case of many of our other native plants, is to collect some soil from the immediate surroundings of the plants you wish to grow. The reason for that is to include some of the associated fungi that the orchid needs to ensure its growth. The correct substrate for both terrestrial orchids and epiphytes is very important—without it a plant doesn't grow, but slowly withers away. If a plant is from a soil type that cannot be imitated, the soil that surrounds the plant may become a constraint, preventing the plant from expanding. Wash off the original soil and replace it with loose, well-drained sand, with some organic matter mixed into it in a one to one ratio. In the winter rainfall areas of the southwestern



Terrestrial Orchids In The Wild

I advise leaving the plants in the wild, rather than collecting them and consigning them to the compost heap by not providing similar conditions in the nursery to what they are used to in the wild. Rather put the effort into conserving the wetlands and general habitat of the species you are concerned about. Maintain the natural habitat of a minimum of 3–4 hectares for some of the highly localised terrestrials and keep stock out during the period of flowering and pod formation. Once pods have split to shed their seed, animals can be grazed over the population for a short while. Miraculously, against all odds, the orchids still survive on the farms in KwaZulu-Natal. Continued management and monitoring of the species in its natural habitat will do much more to save it from extinction than a complicated, *ex situ*, high-maintenance programme, which isn't necessarily fool-proof.■

◀ Eulophia cucullata *is an indicator of relatively undisturbed moist grassland. It is difficult to maintain in cultivation and thus it is imperative that the moist grasslands and wetlands that harbour these orchids in southern Africa are protected from humans and their livestock.*

Cape, less organic matter is better—use one part compost to 2 parts sand.

It is preferable not to take mature plants. If it isn't possible, remove plants when they are dormant. Push a spade into the soil about a spade's width from the plant to dig around it. Repeat the action until a square has formed that you can lift out. Remove the block of soil without disturbing the orchid tubers.

Attempt to grow these plants in similar climatic conditions to those that exist in the wild. Again, this is not an easy proposition when many of these orchids grow in wetlands and at relatively high altitudes and the garden you wish to transplant them into is often at a different altitude. Correct drainage is of utmost importance.

TIP

To aid proper drainage, add more drainage holes in the vertical side of the lower third of the pot or container's surface.

Watering

Watering terrestrial orchids is an art. One may well want to know why an orchid, which is supposedly very delicate, needs to store water in its roots or stems while growing in a marsh. Keep in mind that Africa is a continent of extremes and many of these marshes dry up in the winter or dry season months. During this time, the orchid rests by becoming completely dormant. Before the rain starts anew, it needs to have resources available to grow again, hence its storage organs. Do not overwater plants during the dormant period, but ensure that they do not dry out altogether.

Guy Upfold, an orchid grower in KwaZulu-Natal designates *Satyrium*, *Habenaria*, smaller-growing *Bonatea*, and *Disa* as problem plants, because in winter when they become dormant, they also become very sensitive to too much or too little watering and expire easily. The easier plants to grow include *Disa polygonoides*, *D. woodii* (these were found to even seed themselves in the greenhouse), forest *Habenaria* species, and *Liparis* species They were found to do best in a similar mix to the Eulophias, but with a bit more bark.

Guy Upfold attempted to cultivate *Bonatea sandersoniae*, which did very well for years growing in only polystyrene balls with a bit of coarse gravel on top holding it in place. All the other plants that he attempted to grow in different mixes failed and died in winter.

He has had success using the same fertiliser mix that is used for the epiphytes, which is a dilute mix (half strength) of a liquid fertiliser. He has found that the controlled-release fertilisers, like Osmocote and Horticote, present better results when added on top every few months. He has drenched the plants to stop salt build-up—a regime the plants didn't seem to mind at all.

He admits that growing orchids in the open or under shade has been almost impossible, except for a few marsh-growing species. He has had to control the watering carefully, as most of the problems started when the plants were not allowed to dry out before the next watering session, causing the plants to rot. He finds that it is easier to grow plants that need to be wet, like *Eulophia horsfallii*, *E. angolensis*, and *Calanthe sylvatica*. He has managed to grow them in composted bark and applied

water almost daily, whenever he watered the epiphytes. He never stood them in water.

Gareth Chittenden, who is another KwaZulu-Natal grower, has a *Calanthe* in leaf litter sitting in a tray of water that seems to be doing well. He has found that other species, such as *Liparis*, *Acrolophia*, *Bonatea speciosa*, and *Oeceoclades* are not too difficult to grow.

Ventilation

It is vital to keep the leaves and particularly the growing point of most of the terrestrial orchids dry. Water running into the crown of *Eulophia* species will lead to rapid rotting. This applies to all the plants that are under shelter in a growing house. The air around the plants should move constantly, making it important to open the sides of the structure. It is a good idea to have upper roof vents to allow the hot air to escape.

▲ *pH and EC meters that are commercially available for testing soil.*

Feeding

Feeding is important, as most of the boggy orchid habitats are acidic. The pH should be about the same as in the wild, implying that soil tests for acidity need to be done. A couple of methods can be used to test the soil. The first is to use strips of impregnated paper, which, when dipped in the soil, will display a colour that can be checked against a chart. The other method is to use a pH meter, which is relatively expensive to purchase, and has to be used with care. The meter has to be calibrated, using buffering solutions that are supplied with the instrument. The best method always is to read the instructions carefully.

Another method is testing soil for its Electrical Conductivity (EC). This is a simpler method, provided instructions are followed carefully. Soil should be around 1,2 EC, but for propagating soil or media, 0,6–1,2 EC is better. If the reading rises above 3,2 EC, it is far too salty and verges on toxicity. (1 EC is equal to 100 microSiemens.)

Some growers use organic fertilisers, such as Multifeed, Kelpak, and Seagro with trace elements in combination with normal soluble liquid fertiliser every other week. It is important to feed with trace elements only in summer or during the normal growing season.

TIP

Specialist plants all prefer rainwater instead of borehole or municipal water.

Grassland Eulophias

Guy Upfold has tried a few ways of growing small grassland Eulophias. He claims that soil from the natural habitat doesn't prevent the plants from rotting, as it doesn't drain fast enough. The best results are obtained from a mixture consisting of half river sand, half fine composted bark (seedling mix) and polystyrene balls to make the soil mix lighter. Provided the plants are allowed to dry out between watering, they do well.

Furthermore, they need to be under a roof. He has found that the less *Eulophia odontoglossa*, *E. leontoglossa*, *E. parviflora*, *E. foliosa*, and *E. clavicornis* are disturbed when growing and the more pot-bound they become, the better. He has used only clay pots and has never even tried plastic. He has found that these plants are very sensitive to the fertiliser strength used for epiphytes, which seems to burn the leaf tips.

In an article that Graham Duncan of Kirstenbosch wrote in *Veld & Flora* in March 2000, he clearly describes how he maintains *Eulophia horsfallii* in cultivation. He grows *Eulophia* in deep trays and in pots. He uses a mix of coarse river sand and milled bark and finds that the plants seem to like it. He finds that some species multiply vegetatively quite well, but others don't, and ultimately don't live long in cultivation.

The main reason why most orchids cannot be raised successfully from seed sown under normal conditions (as one would sow a tray of *Lachenalia* seeds, for example), is that the seedlings of most of them are dependent for their survival on a symbiotic association with a specific fungus. The fungus penetrates the roots of the orchid seedling, and through the exchange of nutrients, the seedlings are benefited. It is especially during seed germination and subsequent growth of the seedling that the orchid's dependence on its associated fungus is greatest. In addition, further requirements for germination of viable seeds, such as sufficient moisture, favourable temperature, and light levels, have to be met. The tiny, dust-like seeds of orchids are very well adapted for wind dispersal.

It is remarkable that in Kirstenbosch, many hundreds of kilometres from the nearest naturally growing *Eulophia horsfallii* populations, fungus occurs that allows seedlings of this species as well as *Eulophia petersii* and *Bonatea speciosa*, to grow from seed.

I believe that Eulophias are probably the most easily cultivated of all the southern African orchids, and generally most suitably grown in shallow containers in a very well-drained medium, consisting of equal parts of coarse river sand, milled bark and well-rotted compost. In my experience, the evergreen species are usually easier to grow than the deciduous ones, and evergreens, such as *E. horsfallii*, *E. streptopetala*, *E. petersii*, and *E. speciosa* can also be successfully grown in gardens under optimum conditions.

Terrestrial species need heavy watering every few days, as soon as the containers have properly dried out from the

last application. Once winter arrives, watering and feeding should be tapered off and stopped completely. Many species of terrestrial orchids live in woodlands where trees are deciduous. The leafless trees of winter woodlands allow more sunlight to penetrate during the dry season. Plants under cultivation can be placed in similar positions where they are exposed to higher light intensity. Plants can be re-potted a week or two before their dormancy is broken by watering. This is also an opportunity to divide clumps, because new growth of shoots or roots is not damaged.

Organic matter in the form of well-rotted compost or leaf litter is necessary for mulching. The leaves do not only help to smother weed seedlings, but act as a form of slow-release fertiliser as well.

All orchids respond to regular applications of liquid fertiliser. Most growers use organic brands and the seaweed-based fertilisers. Commercial nurseries tend to use a combination of both inorganic fertilisers and the organic brands. Concentrations are important and I often err on the side of applying less fertiliser. In fact, I tend to dilute my fertiliser applications by half.

Satyrium

Satyrium is difficult to cultivate, because in winter when they become dormant, they also become very sensitive to too much or too little watering and expire easily. Guy Upfold never managed to find the right mix for *Satyrium*, which would grow fine and flower in summer, but never reappear after winter. Graham Duncan grows *Satyrium* in pots, in a very sandy medium that consists of equal parts of silica sand (swimming pool sand) and finely sifted acid compost.

Epiphytic orchids

I have grown epiphytic orchids for as long as I can remember. The same rules that apply for the terrestrials apply here, but they are simpler.

Altitude is a major factor. Observe the plants in the wild before bringing them back to a shade house. Some orchids will not survive at the coast at all, including *Angraecum conchiferum*, *A. sacciferum*, *Diaphananthe caffra*, and *Polystachya transvaalensis*. All these orchids are from the higher altitude mist belt, or as it is now called, the Afromontane Forest in KwaZulu-Natal.

Orchids need high humidity, combined with cooler night and even day temperatures. These orchids will not survive for longer than one summer on the coast, in the absence of specialised growing houses, because the temperature range is too constant. The same is true for the more northern countries of southern Africa, for example, Malawi, Zimbabwe, Zambia, and Angola, where lowland species will generally survive cooler climates, but cooler, high humidity forest orchids will not survive in the hot lowlands.

► Eulophia horsfallii *showing flowers and developing pods. This is an easy plant to establish and keep in cultivation given the right conditions.*

Propagation

Orchid propagation is becoming popular, but it does take specialist skills and equipment to make it work. For most species, it requires the use of an *in vitro* method of propagation, that is, sowing the seed onto a sterile, jelly-like medium, often called agar. This medium provides all the nutrients needed for germination and future growth.

I have had success growing some epiphytes from seed just by scattering the seeds from splitting seed pods or capsules along the roots of the parent plants. Fungi live with these plants, in association with their roots and with this method of scattering the seed, if you do not water too vigorously, you will have some success. In the wild, this often happens on an orchid-festooned branch where you find young plants growing in the ridges provided by their parent's roots.

Another method of propagation is to divide larger clumps of sympodial and monopodial orchids, but this division should be done in late winter, just before the new roots begin to appear. The trick with epiphytes is to make sure the piece you are taking off the parent plant has some well-established roots to carry on feeding the new offset. Tie the divided plant tightly onto the substrate so that the roots can reattach themselves to the new medium. I use nylon stockings cut into broad strips to tie the orchids onto their new substrate. The nylon is elastic and binds the roots firmly, but gently, and it is soft enough to allow roots to grow through the nylon.

Substrates

Growing terrestrial orchids on different substrates is key in their maintenance. Specimens of *Ansellia africana*, *Mystacidium capense*, *Polystachya pubescens*, and *Cyrtorchis arcuata* have been in my collection since 1972. All of them are growing on living trees and have been moved at least three times to different parts of KwaZulu-Natal. Under cultivation, the substrate should be left undisturbed for at least a while to give the orchid a chance to establish its roots on the medium. Once the roots are established, they are able to provide the plant with food. The absence of roots implies a sick plant and no growth.

I use branches from the introduced Australian Bottlebrush tree (*Callistemon viminalis*) as a good starting point. The branches must be less than 50 mm in diameter to enable the roots to twine over the rough, fissured bark. Some growers use Cork Oak (*Quercus suber*) bark, but I have found that this bark is too thick and harbours all sorts of insect pests that attempt to eat the bark and affect the growth of the orchids.

I have seen another grower use 50 mm nylon hawser rope. The dense twine holds water and nutrients, and the roots of plants like *Microcoelia* and *Mystacidium* do well on this medium. Another grower uses old grape stems, but one has to be in a wine-growing area to have access to this medium.

Some growers use inert human-manufactured media, such as hardwood slabs, rock wool, polystyrene balls, and charcoal. These media are placed in either clay or plastic pots and the plants seem to do well. Air movement is the key to successful cultivation. The plants need to be well-ventilated to prevent insect and airborne pathogen buildup in the shade house.

I know of one grower who uses no media other than a piece of wire to hold the plant up on an overhead line. The roots just grow out in the air. In this case, humidity and feeding are of critical importance, implying that missing one day sets your plants back considerably. His plants seem to be happy and produce many roots that are able to absorb water and nutrients.

◀ Ansellia africana *seedlings that were propagated using tissue culture methods, now growing in multi-trays in florist foam. These seedlings are in their second growing season.*

▼ Ansellia africana *seedling that has germinated on the rotting tissue of a tree branch that has been cut. This is natural regeneration. Note the young fig tree growing under the same conditions.*

special feature

Winter-rainfall Disas

by Louis Vogelpoel

The winter-rainfall Disas, of which *Disa uniflora* is the best known, need very special conditions to grow. Louis Vogelpoel, an orchid grower of note in Cape Town, grows winter-rainfall Disas to perfection. He believes that successful cultivation depends on simulating the natural habitat to which the Disas have adapted. Moreover, the cultural regime has to be adjusted to be in harmony with seasonal changes.

- Disas need a nutrient-poor, acidic growing medium.
- Never overpot. Use small, 10–15 cm pots containing a well-drained medium, such as silica grit and sand mixed with palm fibre 10:1 to permit good aeration.
- Water should be pure and very low in dissolved salts with a pH of 5–6, for example, rain, mountain stream, or de-ionised water. Water the plants daily and allow the growing medium to nearly dry out between watering sessions. Water may be supplied from above, and or below. Drain away excess water to maintain the oxygen at the roots. Water less in winter to reduce bacterial and fungal rot.
- Feeding should be rich in inorganic, macro-, and micronutrients as used in hydroponic feeds, but in very dilute concentrations.
- Monitor and maintain total salt content at less than 300 microSiemens (3 EC) on the electro-conductance meter. Feed daily in the rapid growing season of spring and autumn; stop feeding after flowering and only once a month in winter.
- Keep the temperature of the medium around the roots low, between 5–15°C in winter and 10–20°C in summer. The ambient temperature in summer can go above 30°C as long as the pots are kept cool with a top dressing of coarse fern fibre, pebbles, or living sphagnum moss and frequent watering.
- Maintain humidity above 60%, as the leaves are soft and lush.
- Maintain free air movement at all times; never permit hot, dry, desiccating winds—these can be lethal.
- Allow bright, filtered sunlight with exposure to blue sky light in the growing season (spring and late summer) for optimum health and flower colour production. However, keep seedlings and young plants shaded.
- All Disas die after flowering and survival depends on the formation of new tubers from the stem or from a root called a dropper. The new tubers take three months to make healthy new leaf-shoots and root systems.
- Do not re-pot immediately after the plants have flowered, but defer re-potting until the new growths are vigorous in autumn. Premature re-potting or feeding or other stresses can prove fatal if the vital renewal process is disturbed.

Terrestrial Disas

Graham Duncan grows *Disa spathulata* (=*Herschelianthe spathulata*), which is a terrestrial. He grows them in terracotta pots in a mix of river sand, silica sand, and soil from the habitat. When he divides these plants, he always incorporates some of the habitat soil with the divided plants to allow the mycorrhiza to continue growing in association with the roots of the plants.

Evergreen Disas

In a similar way to other indigenous terrestrial orchids, a special growing area should be set aside for the evergreen Disas, whether the collection is small or large. This is to ensure constant attention to detail, cleanliness, hygiene, and provision of basic requirements throughout the season. In this way fungal and bacterial rots can be minimised and damage from mites, thrips, insect larvae, and caterpillars avoided.

The evergreen Disas, if allowed to flourish, produce flowers within three years of sowing. New growers are encouraged to raise their own plants, thereby increasing their collections and contributing to plant conservation.

The seed of the evergreen Disas is unique compared to that of the other southern African orchids. It is much larger and designed to be dispersed by water. It germinates on a damp surface of sterilised peat or sphagnum moss within six weeks of sowing, without depending on mycorrhiza. Unlike other orchids, plantlets of these species can be raised without the need to grow on nutrient agar in a sterile flask, although the latter is the preferred method.■

▼ **left** Disa tripetaloides *from the Kleinmond area of the Western Cape, growing on the side of a stream in the mountains;* **middle** Disa longicornu *growing on Table Mountain in Cape Town. This species grows on south-facing cliffs in deep moss and virtually permanent shade;* **right** *A bench of well-grown* Disa uniflora *at MacGregor grown by the late Piet Marais. Note the "lip" on the edge of the bench which prevents pots from tipping over and allows you to place stone chips on the bench to hold moisture and allow for drainage.*

Feeding and humidity

It is important to feed epiphytes correctly. A dilute liquid fertiliser is the best option. Each grower has his or her own recipe. Find a couple of available brands, one inorganic with trace elements, and the other organic, such as the various seaweed extracts, and alternate these types. I spray my orchids weekly in the growing season with a dilute, half-strength mixture. Between feeds, I ensure that the plants are properly wet and drenched to leach out any remaining salts that may still be sticking to the substrate. This drenching is especially important for plants growing in pots. It is another reason to use only inert media like stones or polystyrene. Feed at least once a week in the growing season. Some growers feed every time they water the plants by having a fertiliser applicator attached to the watering system. This isn't necessary if you have a simple growing system. In this case, the most important point is to let the plants rest during the dry or cooler times of the year.

During this time of rest, they do not need any feeding whatsoever. They only need a daily damping down to maintain the humidity. I try not to wet the plants at all, but focus on the surrounding vegetation and greenhouse floor. I find that epiphytes tend to grow more vigorously if you have other plants of similar habits growing in the same shade house. Plants like *Impatiens*, *Streptocarpus*, *Clivia*, and *Begonia*, ferns and certain forest-dwelling terrestrial orchids, such as *Calanthe*, *Oeceoclades*, and *Stenoglottis*, tend to live in similar habitats. My theory is that if there are enough of these supplementary plants in the glasshouse where the epiphytes are growing, they transpire and help maintain the humidity, keeping the orchids relatively happy during the dry months.

Naturally, there are limitations to this approach—the biggest problem is insect pests, which have a way of overwintering and re-infesting the collections. Greenhouse hygiene and constant vigilance and maintenance of all the plants are the keys to preventative pest control.

Watering

Ensure the provision of good quality water. Some municipal supplies have high concentrations of chlorine in the water. This chemical is deadly to all living things. If in doubt, rather store the water for a day in a tank to allow the chlorine to volatilise.

It makes sense to collect rainwater in a tank. Use this water to irrigate container-based and epiphytic orchids. Rainwater is far better for plants than municipal or bore hole water. Work out how many litres of water are needed daily and do the calculations to see how big the tank has to be to store enough water for six months or even a year.

For more about water harvesting, see the list of addresses on the inside back cover.

Sunlight

Another factor to be taken into account with epiphytic orchids is that sunlight early in the morning and sun in the evening are good for these plants, while midday shade is necessary. Low-angled light does not burn or scorch the plants, whereas direct, high-angled light is a killer of delicate plants. I find that a 70% black shade cloth is best for the shade houses. If you have *Ansellia africana*, *Microcoelia exilis*, and *Angraecum cultriforme* that enjoy higher light intensities, place these plants on the edge of the shade house that receives the most light.

Alternatively, lathes, thatching grass, reeds, or palm fronds can be used to cover the framework of the shade house, instead of shade cloth. Gaps of about 10–20 mm should be left between the plant stems. Orientate the lathes in a north–south direction so that the sun moves across the lathes. In this way, the lathes will provide light and shadow in a moving pattern, preventing leaves from being burnt.

▲ Oxalis *collection at Kirstenbosch.*

OXALIDACEAE

Wood sorrel family

Most of the species of this family occur in the winter-rainfall region of South Africa, with a few summer-rainfall species.

Oxalis is relatively easily grown from the many bulbils that form on the parent bulb, or from the two different types of seeds produced, depending on the species.

The first type has a hard seed coat that can be stored for up to a season after harvesting. In the other type, the seed coat is explosive and the cotyledons are ejected and

▲ Adenia gummifera *fruit.*

ready to germinate. Seeds of this type are only viable for a few days. These seeds need to land on a suitable substrate very quickly or else will dry out and die. *Oxalis* need to be well fed and watered during the growing season and allowed to rest during the dormant period. Use a loose, well-drained, relatively sandy soil for the plants. Many *Oxalis* species have contractile roots that draw the bulbs down into the pot or soil. Ensure that the container is deep enough to accommodate the movement. A 150–250 mm pot is ideal, as this enables the plant to live in the same pot for a few years without being disturbed.

▲ Adenia gummifera *seed. Note their distinctive pattern of pitting.*

PASSIFLORACEAE
Granadilla family

Adenia gummifera grows easily from cuttings. Other species of this genus will root from stem cuttings if they have twining stems. Stem cuttings have to be taken at the beginning of the growing season.

Propagation from seed works well, provided it is sown fresh. I have collected and potted seedlings that have germinated under mature plants of *A. gummifera*. Furthermore, I've had great success with seed of *A. gummifera*, *A. spinosa*, *A. digitata*, and *A. hastata*. As with all other *Adenia* species, the seedlings need to rest during the winter months. Be strict not to water or feed the seedlings during the dormant period.

Schlechterina mitostemmatoides is a rare medicinal plant from the Granadilla family that occurs in the sand forests of the east coast of Africa. In South Africa, its roots are highly prized for their medicinal properties. Flowers are produced at the terminal end of growing stems in the upper canopy of sand forest trees out of sight of humans. This is an interesting and rare species and also occurs in Mozambique, Tanzania, and southern Kenya.

Basananthe should be grown from seed. Although the seedlings need sunlight, shelter provided by grasses is important to keep the roots in the packets cool. I have used clumps of grasses, such as *Aristida junciformis* and *Melinis repens,* to shelter the seedlings. The shelter allows the seedlings to become established without the intense heat that plants in the open sun on open planting terraces are exposed to.

PEDALIACEAE
Sesame family

Given the fact that *Sesamothamnus leistneri* is a succulent, I suspect that it can be propagated from cuttings. It also grows from seed. To collect seed, watch the plants closely and mark your gardener's diary so that you can repeat the seed collection the following season.

Harpagophytum procumbens has been propagated using tissue culture (Shushu, 2001).

The seeds of *Sesamum* and *Ceratotheca* do not germinate when sown immediately. Let the seed dry out during the dormant season and sow it in the new growing season. These plants tend to be annuals. Some live in areas that are characterised by cold winters, implying that seed may well need a cool dormant period before germinating.

▲ **left** Schlechterina mitostemmatoides *flower (Photo: Mark Ward);* **middle** *Mature leaves of* Schlechterina mitostemmatoides. *An interesting trait of this creeper species is that has two or even three leaf forms, making it difficult to find in its forest habitat;* **right** *Immature leaf shape of* Schlechterina mitostemmatoides. *This is the more commonly seen form in South Africa. Animals browse the plants and the family Passifloraceae is also the food plant for the larvae of* Acraea *butterflies.*

PHORMIACEAE

I have seen *Dianella ensifolia* on Mahé Island in the Seychelles, a robust plant that grows on the exposed areas on top of the main mountain of Morné Seychellois. If *Dianella ensifolia* in Zimbabwe is anything like its cousin in Seychelles, it should not be difficult to propagate. I would suggest using the method of division on the parent plant. Establish the plants in a shaded growing house and slowly wean them to a more open spot. Propagation from seed is a good option, provided you reach the plants at the right time. The fruits are a lovely deep blue colour and contain a single seed that germinates if sown immediately (Friedmann, 1986).

PLUMBAGINACEAE

Leadwort family

Both the dry-loving *Plumbago* species in Namibia, *Plumbago wissii* and *Plumbago pearsonii,* will grow from seed, provided the plants are harvested at the right time of the season. Again, this is a matter of observing the plants over a season. Seed of this group is sticky to the touch. It should be harvested and left to dry and split in a tray lined with newspaper. Place in a dry cool area.

Once the seed is shed from the husks, sow it on the normal seedling mix. Collect a little soil from around the parent plants to inoculate the potting soil. Imitate the watering routine characteristic of the plant's natural habitat. If propagation from cuttings is attempted, these should be taken at the beginning of the growing season.

▲ Plumbago zeylanica *seed capsules showing the sticky hairs that help attach the capsule to passing animals in order to disperse the seeds.*

However, in my experience, propagation from cuttings is tricky in the case of the more common *Plumbago* species—low strike rates seem to be the norm. Chances of cuttings rooting successfully would probably be enhanced in a mistbed with bottom heating.

I have not seen the Namibian species, but suspect that they do sucker. If this is the case, remove a sucker or two from each plant, including a bit of root with each sucker. Grow these on in a controlled, optimum environment, such as a glasshouse, until the plants are established.

▼ *Mike Kruger with the grass seedlings that he germinates for commercial use.*

▲ **left** Oxytenanthera abyssinica *plant in the Zomba Botanical Garden;* **right** Oxytenanthera abyssinica *plant in flower, Zomba.*

POACEAE
Grass family

Grasses do not seem to be under severe threat. They are, however, quite prone to human and animal pressure.

Clumping species can be divided or split into pieces. Ensure that about a third of the leaf area is pruned and replant the pieces quickly. Do not let the exposed areas caused by the split dry out. Water well once replanted. Grow the plants in the habitat and region where they were collected. High altitude species need to be grown at the same altitude to survive.

Stoloniferous grasses grow well from stolons or runners, producing new roots at each node. As long as water and soil are provided, the species grows. As with most other plants, this form of vegetative propagation should be undertaken as the new growing season or rainy season starts.

The large grasses, such as bamboo, are easily grown from divisions, provided it is done after the resting period, when the plant is just starting to grow anew. The Berg Bamboo (*Thamnocalmus tessalatus*) grows easily, but needs water and shelter to establish. I even managed to grow it on the coast for about two years, before it was overwhelmed by heat and humidity one summer. The Berg Bamboo is also stoloniferous—remove the stolons at the beginning of the growing season. Remember that at

▶ Oxytenanthera abyssinica *inflorescences. Various seed-eating birds like Pied and Red-backed Mannikins feed on the anthers.*

▲ *Grass seed mainly falls into the fine seed category. Here the seed can be seen germinating in shallow seedling trays kept at a temperature of 30°C.*

high altitude the season of growth is relatively short and it may be better to protect the new plants during their first winter in a tunnel or glass house where the temperatures may not reach freezing point if there is heating.

Oxytenanthera abyssinica also grows from divisions, but is larger and slower to establish. Use a stolon or section of stem, including at least three or four eyes to ensure that at least one will be established. Make the division about 2–3 weeks before the new growths normally appear above ground at the beginning of the new growing season. This means you should observe the plants closely during the previous season to make sure when the new "spear" shoots should normally appear.

Olyra latifolia has a disjunct distribution in South Africa and occurs in low densities in the forests that it inhabits. The best way to grow this species is to divide the plants in spring as soon as they start growing out. Although seed is produced, forest-dwelling birds eat a great percentage. Seed germinates as long as the seed is sown fresh. It is important that the conditions are humid and the temperature is maintained at approximately 30°C. The plants should be grown in a humus-rich soil of leaf litter and a potting medium with more soil than what the normal commercial pine bark-based media contain.

POLYGALACEAE
Milkwort family

The rather cryptic plants of the genus *Polygala* tend to be under-collected, for example, *Polygala friesii, Polygala westii, Polygala francisci, Polygala limae, Polygala torrei, Polygala guerichiana*, and *Polygala lasiosepala*. They inhabit grassland biomes and are grazed on by livestock. Bringing these plants into cultivation is problematic, because they usually flower early in the season, set seed, and disappear in the grass sward. Once propagated, maintaining these plants is not that difficult if you are prepared to give the plants plenty of care.

Some of the more robust species grow from cuttings, such as *Polygala myrtifolia*, *P. fruticosa*, and *P. virgata*. Take cuttings in early spring to ensure the best results.

Collect seed as the calyx bracts start to change colour from purple to tawny. Pop the seeds out of the calyx covers and sow on normal seedling mix. Watch the smaller

▼ Anacampseros *seedlings.*

▶ Thamnochortus insignis *seedhead.*

species closely not to miss the moment when they drop their seeds. Marking plants with tape or other markers is useful.

Securidaca longepedunculata trees need to have their seed collected and sown. Try to get fresh seed. I know in the Kruger National Park that the seed is collected and stored for a season and the seed does germinate. Crush or remove the wing from the seed.

Nylandtia scoparia is a shrub from the southwestern Cape that bears fleshy fruit. The seed has to be cleaned off and sown in a sunny location onto sandy, humus-rich soil.

PORTULACACEAE
Purslane family

When thinking of this family, I am reminded of dry places and succulents. The keys to growing these plants successfully are treating them as succulents and imitating the growing conditions that apply for each genus.

Ceraria namaquensis inhabits a dry climate and has roots that are sensitive and rot easily if exposed to too much water. It has been grafted onto the more common species, *Protulacaria afra*, which has a wider amplitude of survivability. By grafting *Ceraria* onto *Portulacaria*, one can grow *Ceraria* in wetter climates and possibly even get seed from it if more than one clone is grafted on the Portulacaria rootstock (Saunders, 1992).

Cuttings and seed of *Ceraria*, *Anacampseros*, *Portulaca*, and *Portulacaria* will all grow if dealt with in the way succulents are dealt with generally. The seeds are fine and light and are carried along in the breeze. When sowing these seeds, it is important not to cover them too deeply and to make sure that the tray is exposed to plenty of light (Van Jaarsveld, 1987). Many of these species are used medicinally by traditional healers and can easily be propagated for this trade.

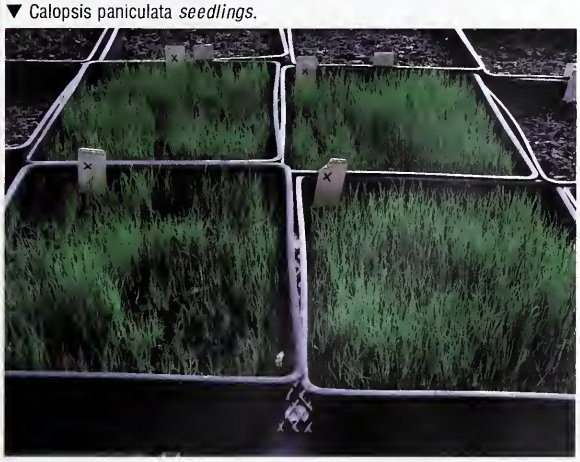
PROTEACEAE
Protea family

See the sections on fynbos seed and cuttings in Chapter 2 and Chapter 5 for advice on how to grow this family of plants. For more information, consult the following references: Winter (1977), Van Staden (1978), Vogts (1982), Crous (1995), Brown *et al.* (1998).

RESTIONACEAE
Restio family

See the sections on fynbos in Chapter 2 and Chapter 5 on how to grow Restios.

◀ Portulaca quadrifida *plants growing on a rock plate in shallow soil.*
▼ Calopsis paniculata *seedlings.*



▲ Cassipourea gerrardii, *a split ripe fruit presenting the orange aril to attract the dispersal agent. (Photo: Gareth Chittenden.)*

Division is the vegetative method to propagate these plants. When propagated from seed, smoke treatment is important to ensure good germination.

For more information, consult the following references: Jamieson (1996), Brown *et al.* (1998), Brown *et al.* (1999), Haaksma & Linder (2003).

RHAMNACEAE
Buckthorn family

This family is propagated from seed. Clean off the outer coating of the nut to expose the seed within. Most of the members of this family are pioneers that need full sunlight for germination and future growth. A species like *Helinus* has fairly hard fruit. Crack the coating to allow water access to the seed so that the germination process can start. Use sandpaper to nick the hard coat of *Ziziphus mucronata* and *Ziziphus rivularis* seed, or crack it in a vice.

◀ *Cleaned* Ziziphus mucronata *seeds—the hard outer seed coating has been removed.*

RHIZOPHORACEAE
Mangrove family

The genus *Cassipourea* is best propagated from seed. The *Cassipourea* species that I know, including *C. gummiflua*, *C. malosana*, and *C. swaziensis*, produce masses of seed in summer. Collect fruits that are splitting, clean the seed by removing the orange aril, and sow it on seedling mix. Seedlings take about 10 days to germinate. Prick them out into bags.

The mangroves pose a problem for any plant propagator, as they demand specialised care. Seed is the only way to propagate *Bruguiera gymnorrhiza*, *Rhizophora mucronata*, and *Ceriops tagal*.

For more about mangroves, see Berjak *et al.* (1989).

Vivipary in mangroves

Mangroves in the Rhizophoraceae have the interesting feature that the seeds germinate while still attached to the parent. This is one of the few examples of vivipary (live-bearing) in plants. This method of germination is an adaptation to the extreme nature of the plants' habitat. To grow these plants, collect fallen seedlings and place them in a very dense clay soil that is inundated at least once a day to mimic the tidal effect of the sea. These plants can only really be cultivated in tidal lagoons or estuaries. I do not know of any of these plants surviving more than two seasons in cultivation. To extend a plant's life to years, the person looking after it needs to understand the mechanics of mangrove swamps.■

▶ Ceriops tagal, *the Indian Mangrove, showing the similar shaped seeds ready to spear themselves into the mud below. This species is found in Mozambique and northwards on the East African coast.*
▼ *Vivipary: germinating Black Mangrove seed* (Bruguiera gymnorrhiza).

▲ **top** Prunus africana *fruit;* **bottom** Leucosidea sericea *seedhead.*

Rosaceae
Rose family

I have always had success growing *Prunus africana* from seed. Collect the ripe fruit that has turned a purple-black colour. Clean off the outer flesh and sow the cleaned seed within a day in a normal seedling mix. The seed must be kept warm, moist, well lit, and well ventilated to germinate. Bottom heating to warm the soil achieves the best results. Seed germinates within three weeks.

In this group of plants, *Prunus africana* is overutilised, making *ex situ* cultivation to supplement wild populations a necessity.

Fine seed of high altitude species, like *Leucosidea sericea*, should also be harvested in summer and sown immediately. They can also be grown from soft-tip and semi-hardwood cuttings. This species is not threatened.

I am convinced *Cliffortia* will also grow from cuttings. Always take cuttings at the beginning of the growing season. Keep winter-rainfall species in warmer conditions to induce rooting if a mistbed isn't available. Place the cutting in a warm, sunny cold frame for best results.

Both *Prunus africana* and *Leucosidea sericea* cuttings were dipped in Seradix 2 and had taken root in a mistbed after about 4 weeks.

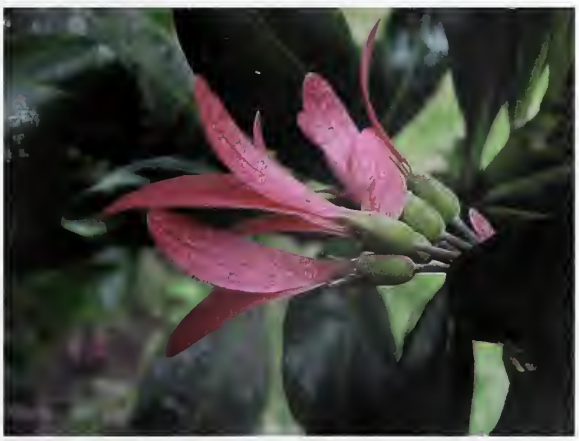
Hagenia abyssinica *was collected in May, sown in September and although there were only about 16 seeds, six managed to germinate. It took approximately four weeks for the seed to germinate without any special treatment. This is a dioecious tree, and more than five trees must be planted to be certain of at least one female plant.*
—John Burrows

Rubiaceae
Gardenia family

This is a family with some very showy and economically important plants, for instance *Alberta magna*. The family is economically significant in the production of coffee. This group is propagated best from collected seed. Monitor the plants carefully over a whole season to determine the right time for seed collection. Once collected, clean off the flesh and sow the seed as soon as possible. During the cleaning process, remove any parasitised seeds.

Seed germinates readily after about 14 days. Once the seedlings are pricked out, they need a good nitrogen-based fertiliser, like limestone ammonium nitrate or urea. If feeding does not happen regularly, the leaves take on a chlorotic look that makes a good gardener's heart skip a beat in nervousness. Apply the fertiliser as a soluble mixture, diluted to half the recommended concentration. Regular, small amounts are best, especially when container plants are watered daily, causing the nutrients to leach out quickly. The genera that benefit from this treatment are *Burchellia*, *Coddia*, *Rothmannia*, and *Hyperacanthus*. The other provision is to plant the seedlings in the open ground as soon as possible, as rubiaceous plants do not like to be contained. I imagine that the reason for this dislike must have something to do with root and fungal associations. Foliar feeding does help, but in high-rainfall areas, they will have to be fed virtually every day during the rainy season.

Alberta magna always seems to get the public's interest and it is always difficult to obtain. Wally Menne has experimented with the propagation of this species from seed. This entailed a thorough cleaning of the seed, which was then soaked in a weak (1%) solution of sulphuric acid for 24 hours and planted in river sand. He has found that the first batch of seed, collected from a tree at the Ngome State Forest office and planted in April, achieved approximately 60% germination in July of the same year. A second batch of seed from Pietermaritzburg was planted



◀ **opposite** Rothmannia capensis *fruits presented so monkeys can get at them!*
▶ Alberta magna *fruit, showing the colourful persistent calyx.*

at the beginning of July (after 10 seconds in the liquidizer) in a bark, river sand, and vermiculite mix and proceeded to germinate almost without exception, approximately two weeks later. From this experience, he has concluded that the seed needs to be subjected to some form of scarification, and has to be planted fresh in June or July, in an absorbent, porous medium. Furthermore, seedlings should be pricked out almost immediately after leaflets have unfurled. He cautions against cats, which seem to take delight in uprooting the small seedlings and eat whole plants of up to 20 cm tall (Menne, 1992).

Propagating these plants from cuttings proves to be slow if they take at all. Soft-tip cuttings taken early on in the new growing season are a better option. A mistbed system with bottom heat works best. One has to experiment with different hormone mixtures, if available.

Forest species, including *Mitriostigma*, *Tricalysia*, *Oxyanthus*, and *Rothmannia*, bear fruit that becomes infected with insect larvae that eat the soft seeds inside the fruit. This may not be apparent from the outside—the fruit may seem fine, until it is opened and the seedless inside is discovered. Collect more fruit than what is needed, from as many different plants as possible, thereby increasing the chance of finding some that are not infected. Furthermore, collecting more broadly helps to improve the genetic diversity of the collection.

▲ *Inflorescence of* Burttdavya nyasica, *a rare tree from Malawi, Zambia, and Tanzania. This specimen was grown from seed in 1980 and flowered for the first time in 2005. It closely resembles* Breonadia salicina.

▼ Breonadia salicina.

RUTACEAE
Citrus family

The seed of the subtropical tree species, for example, *Teclea, Oricia, Vepris, Toddaliopsis*, and *Zanthoxylum,* should be cleaned and sown once the fruit has begun to ripen or split open. Remove the fleshy outer cover and sow the seeds to their own depth on a seedling mix that is kept moist and warm. The place where they are kept should be well lit. Seed germinates in about 2–3 weeks, but seems to take a while to develop. The seedlings remain small for a few years, but once settled, they dart off with a strong leader shoot.

Calodendrum capense has a hard seed coat and should be scarified by filing or sandpapering the seed coat to expose the inner cotyledons. Soak the seeds for a day or so until they begin to swell. This method shortens the time that the seed sits in the soil. Once swelling has started, sow the seed on a warm, moist seedling mix in a well-lit place. Maintain the soil temperature at a comfortable 20°C–25°C. At Top Crop Nursery in KwaZulu-Natal, Mike Kruger turns up the heat to 30°C. I saw the seedlings and they all looked extremely healthy. He manages germination in this way for the majority of the tree species he grows.

For winter-rainfall Rutaceae, such as Buchus, see Chapter 2 and Chapter 5 where I have dealt with plant groups that need the same propagation conditions, such as *Erica* and *Protea.*

▲ Calodendrum capense *seed.*

SAPINDACEAE
Litchi family

All the members of this family that I know, such as *Deinbollia, Blighia, Pancovia, Erythrophysa*, and *Allophylus,* grow relatively easily, although they are a bit slow to establish from seed.

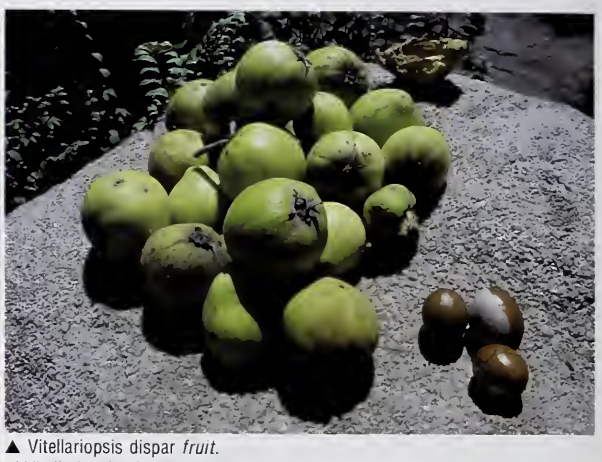
In order to collect seed on a regular basis, large trees should be marked and mapped, and returned to each season. Keep in mind that all the trees will not set seed every season, a fact that compels one to collect from as many trees as possible. This is where a gardener's diary or a simple weekly diary proves helpful. Each time you turn over the page you can see what you did last year or ten years ago—it provides clues and cues for the diligent grower. A wise move is to use a computer to diarise important facts. Remember that back-ups are essential, because, similar to human beings, computer memories also have the tendency to pack up unexpectedly.

Seed must be cleaned and sown as soon as possible—within a day is best. The seed takes about 2–3 weeks to germinate with bottom heat or a warmer ambient temperature. The next stage of growth for a seedling to reach the point at which it can be planted out takes longer. *Deinbollia* and *Pancovia* do seem to sit while contained, whereas when planted out in the ground, they grow quickly. Although I do not have an opinion on the success of propagation from cuttings, seed propagation has always been successful. *Blighia unijugata* trees are uncommon in our forests.

SAPOTACEAE
Milkwood family

These plants do not have the common name of Milkwood for nothing. The sap is sticky and clings to everything it touches. The milkwood family grows from seed without too much difficulty, provided the seed has been cleaned of

▲ **left** Blighia unijugata *fruit;* **right** Pancovia golungensis *fruit ready for harvesting. The flesh is relatively palatable even to humans.*



▲ Vitellariopsis dispar *fruit.*
◀ Vitellariopsis dispar *fruit and seed in Tugela River Valley.*

its outer flesh. For species such as *Chrysophyllum viridifolium* and *Sideroxylon inerme*, take fresh seed and place it in a strong, empty plastic fertiliser bag. Add about a litre of water, 3 tablespoons of sugar and a sachet of instant yeast to the bag. Mix this witch's brew in the bag, seal it, and wait for about 3–4 days until the whole bag looks like an inflated balloon. The fermentation process is now well under way, causing the flesh to simply fall from the seeds. Wash the seed in water and sow it on a normal seedling mix.

It is easier to clean the seed of *Mimusops*, *Manilkara*, *Englerophytum*, and *Sideroxylon*. A great find is a fruit bat feeding zone, where piles of seed or husks are found under the trees. These animals do the cleaning for you. Genets (small, cat-like carnivores) eat the fruit of *Manilkara* and *Sideroxylon* in particular and leaves masses of seed in their middens for humans to collect. I have also collected baboon faeces and sown the contents. The best tally I have ever had for one set of droppings was nine different species germinating!

The seed of *Vitellariopsis dispar* is heavily parasitised in the Tugela River Valley of KwaZulu-Natal, South Africa. The ideal is to collect the fruit while still a little green and peel the flesh off before sowing it. Sow the seed as soon as possible. In my experience, germination rates are high for all these plants. It takes a couple of weeks of good bottom heat, sunlight, and water to successfully germinate the seed.

The flesh that covers the seed of *Manilkara discolor*, *Vitellariopsis dispar*, and even *Vitellariopsis marginata*, is highly palatable and is collected as a survival food, hence the spread of these trees along the foot paths of Africa.

▲ Dermatobotrys saundersiae *flowers and fruits.*

SCROPHULARIACEAE
Foxglove family

The fine seed of *Anastrabe integerrima*, *Halleria lucida*, *Dermatobotrys saundersiae*, *Bowkeria verticillata*, and *B. citrina* is relatively easy to germinate. The seed of the colder-growing, high-altitude species, such as *Bowkeria*, is harvested in autumn. If kept in the lower, warmer end of a refrigerator, the seed can be sown to great effect in the following spring. Sow seed rather sparingly in the seedling trays to avoid fungal attacks. Place trays in a ventilated, well-lit position. I have had success in rooting semi-hardwood cuttings of *Bowkeria citrina* taken in spring and summer. However, this species wants to be grown in the cooler parts of South Africa. Do not attempt to grow it on the coast, because it dies off during the hot, humid months of December and January.

▲ *Seedlings of* Bowkeria citrina, *a rare endemic shrub from the highlands of northern KwaZulu-Natal and Mpumalanga in South Africa. The seedlings are about seven days old and germinating in finely milled palm fibre. They are kept in a warm moist mist bed with bottom heat. After the first proper leaves appear they will be weaned to a sunny area still in the seedling tray until the following spring. These seedlings were germinated in late February in the KwaZulu-Natal midlands.*

◀ Bowkeria citrina *seed capsule in the Ngcaka Forest, KwaZulu-Natal.*

▼ Bowkeria citrina *flower in the Ngcaka Forest.*

▲ **main photo** *This* Solanum *sp. is a shrub-forming species that is a pioneer in the Bushveld areas of South Africa. Seeds can be squeezed out of the soft-coated fruits;* **inset** Solanum terminale, *a forest-edge species. Squeeze out seeds and let them dry for a day or two in the shade and then sow.*

Selaginaceae

Selago is the only genus that I have experience of and it grows from seed if the seed is collected ripe. The seeds are fine and need to be treated like all fine seeds. Where altitude comes into play or drought is a regular occurrence in your region, store the seeds in a dry, cool place for the duration of the dormant or resting period. Sow the seed in spring—germination takes up to 3 weeks. Sow the seed lightly onto a growing medium in a tray, allowing the small plants to develop for a complete growing season. Plant the small plants directly back in the wild or open ground. Our local species seem to grow in shallow, highly leached soils in rocky areas.

▲ Selago *flowers.*

Solanaceae

Nightshade or potato family

The tomato family is a group of plants that consists of trees, shrubs, and creepers. Growing these plants is relatively easy if you are able to get seed. Pick the fruit when it is ripe, clean the seed, and let it dry out for the rest of the dormant or dry season. Sow the seed during the next spring or the beginning of the season in trays on the usual seedling mix. Place the trays in full sun and heat the soil. The seed takes 10–14 days to germinate. Prick the seedlings out into individual bags.

Propagation from seed and cuttings works well for the creeping species. Species such as *Solanum geniculatum* and *S. terminale* propagate successfully from soft tips and grow easily once rooted.

The fine seed of *Nicotiana africana* is like the seed of the cultivated tobacco plants and should be treated like any other fine seed. My suggestion is to keep seed until the beginning of the new growing season for these annual plants to benefit from a full growing season.

Lycium also grows well from seed and should be treated the same as the *Solanum* group. Propagation from semi-hardwood cuttings also works well. I am able to get *Lycium acutifolium* to root without rooting hormone.

special feature

STANGERIA ERIOPUS

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▲ Stangeria eriopus *seeds cleaned ready for sowing. (Photo: Errol Douwes.)*

Stangeria eriopus, the only local representative of the Stangeriaceae is under increasing threat of exploitation by commercial harvesters who supply the medicinal plant trade. This factor, coupled with the historical spread of forestry, urbanisation, cane farming, and other agricultural practices, has led to the continued demise of these plants. Although often mistaken for ferns, Stangerias are true cycads. Being dioecious, separate male and female plants occur, each producing cones, and pollination occurs via an insect vector.

Stangerias are endemic to southern Africa, occurring from Bathhurst in the Eastern Cape, north to the southern extremities of Mozambique. The plants appear to be distributed in a broad belt that follows the coastline, evidently not wider than about 200 km from the sea.

Stangeria is listed as CITES Appendix I. This status restricts trading of plants, and a permit is required for any such trading. Efforts for the active conservation of this plant are currently underway at the Durban Botanic Gardens, where a gene-banking programme has been initiated (*Stangeria* Conservation Project). Plants from the wild are being added to a collection at the gardens, and investigations of various propagation methods are underway. The plants are also available for other research, and may ultimately be used for reintroductions to the wild, should this be considered feasible.

Stangerias occur in a variety of habitats – from open grassland to deep forest, and leaf size is apparently determined by the amount of light available, which demonstrates a degree of phenotypic plasticity. Such

▲ Stangeria eriopus *plant. (Photo: Errol Douwes.)*

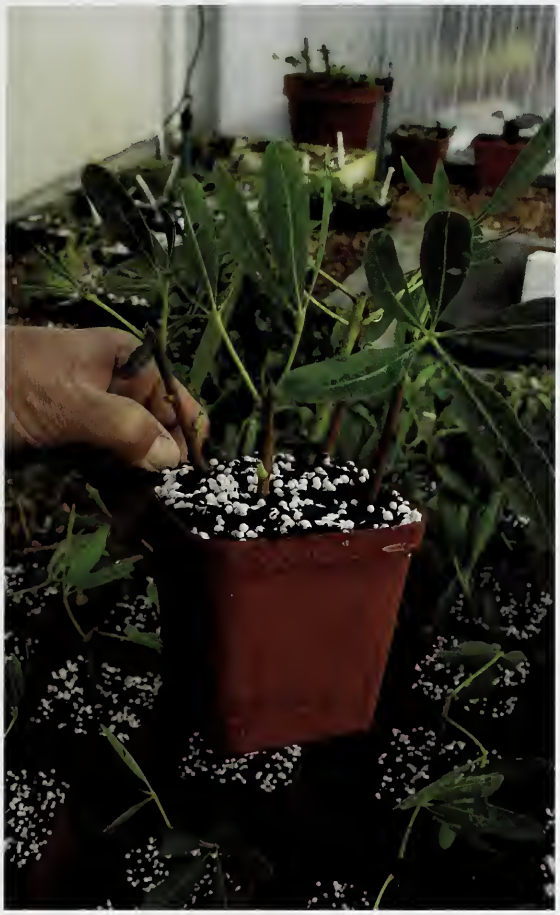
(Continued on next page)

▲ **top** Stangeria eriopus *female cone splitting to release seeds. (Photo: Errol Douwes.);* **bottom** Stangeria eriopus *female cone. (Photo: Errol Douwes.)*

plasticity in leaf size and structure has also been noted in certain fossil ferns, and it is perhaps unsurprising that *Stangeria*'s closest ancestors are some of the now-extinct seed ferns. *Stangeria* plants do not have a visible stem, but rather a subterranean lignotuber. Leaves form and grow from the apex of the lignotuber, the top of which is often five to ten centimetres underground. Coralloid roots are usually present and contain both nitrogen fixing bacteria and algae.

Germinating the seeds of *Stangeria* is easy. Once seed has fallen off the ripe, pollinated cone, they should be cleaned and stored at room temperature (20°C) for two to three months. This allows for completion of embryo development. Seeds should then be placed on their sides in sandy soil, and pressed down to leave half the seed exposed. Best temperatures for germination are between 25°C and 30°C, and watering should be done every two days. Once seeds have germinated they should be placed in pots or bags at least 15cm deep, allowing adequate space for the developing lignotuber.■

▲ Stangeria eriopus *seedlings. (Photo: Errol Douwes.)*



▲ Sterculia alexandri *cuttings. This is an endemic species from the Eastern Cape Province of South Africa.*

STERCULIACEAE
Cocoa family

Sterculiaceae is another family that is relatively easily grown from cuttings, and for the more succulent species, such as *Sterculia*, propagation is more successful from truncheons than tips. However, Kirstenbosch seems to have success in growing *Sterculia alexandri* from tip cuttings.

In my experience, seed is the most successful method of propagation for all members of the family and in particular *Dombeya* and *Cola*. Collect the dried flowerheads of *Dombeya* and carefully split the swollen capsules to reveal the angular seeds within. Sow these on a normal seedling mix. The seedlings emerge within about 14–30 days. Seedlings are small and should be handled with care—the greatest danger of loss is over as soon as more leaves appear.

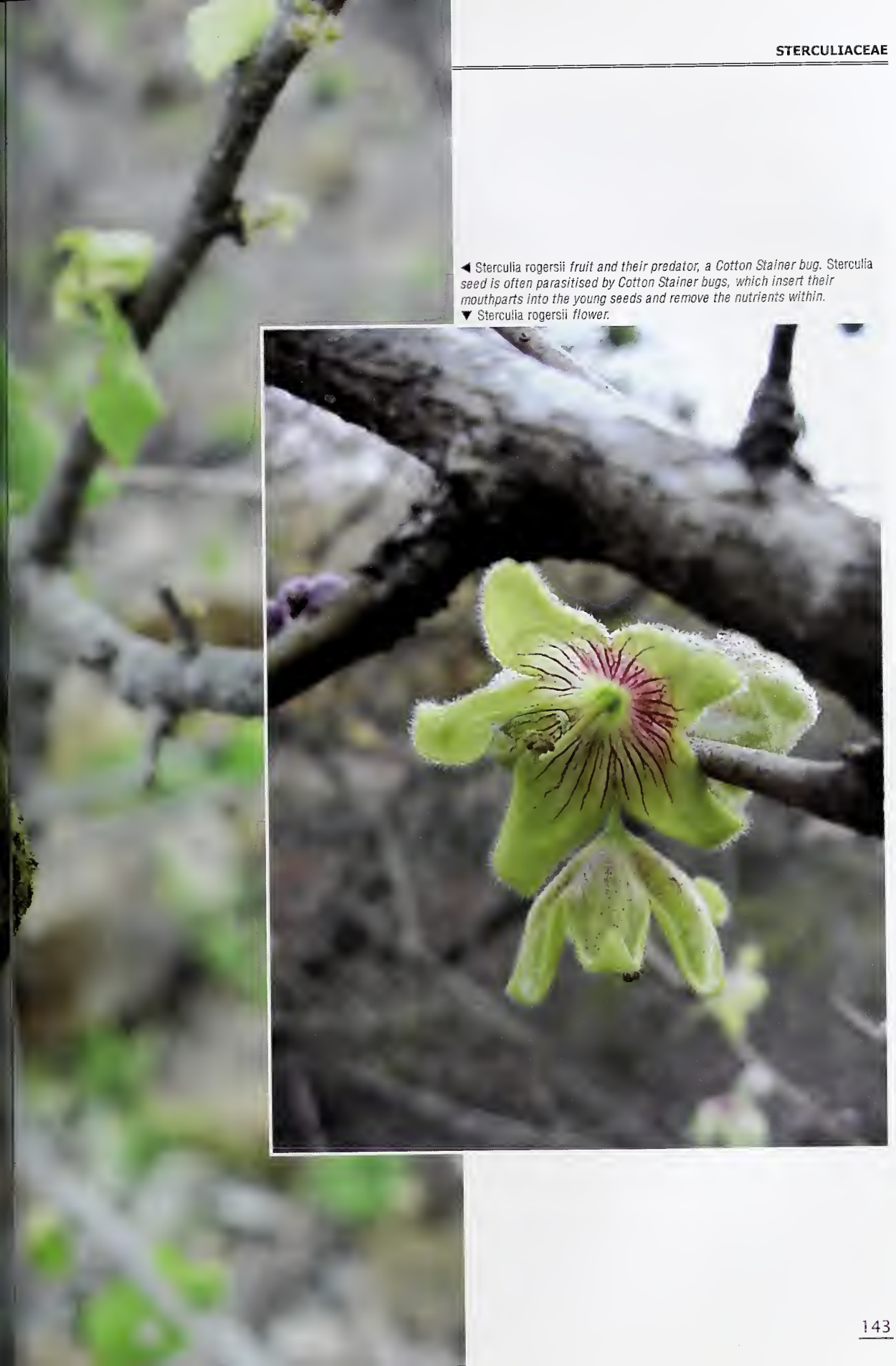
WARNING

The sharp hairs lining *Sterculia* seed capsules can be very irritating. Handle with care.

Collect the seed of *Sterculia rogersii*, *S. alexandri*, *S. murex*, and *S. africana* as soon as the seed capsules begin to split. Lay the capsules on a tray lined with newspaper to dry. When they are dry, the capsules open up and the seeds within are revealed. Removing the seeds from the capsule is a delicate operation that requires leather gloves to protect your finger tips from the fine, sharp hairs that surround the seeds and the inside of the capsule. The dark, hard seeds are easily removed with a strong pair of tweezers or long-nosed pliers. Soak the seeds overnight or until they begin to swell and sow them in sandy humus-rich soil.

Seed of *Cola natalensis* is more succulent and slightly larger than that of *C. greenwayi* and can prove difficult to find, as monkeys and larger fruit-eating birds are fond of it. Freshly sown seed germinates within two to three weeks. Plants establish normally and seem to do well in containers.

▲ Sterculia africana *seed capsules opening on the tree. (Photo: Gareth Chittenden.)*

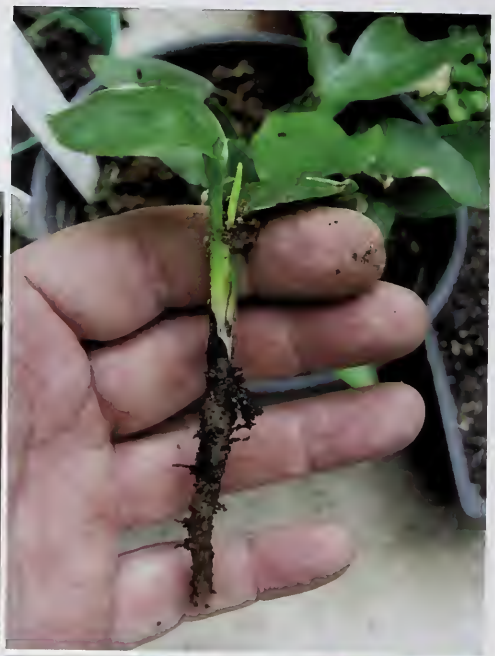


◀ Sterculia rogersii *fruit and their predator, a Cotton Stainer bug.* Sterculia *seed is often parasitised by Cotton Stainer bugs, which insert their mouthparts into the young seeds and remove the nutrients within.*
▼ Sterculia rogersii *flower.*

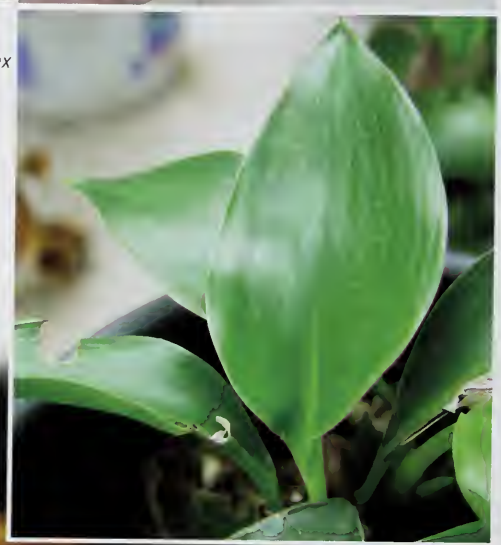
STRELITZIACEAE

Bird of paradise family

Chit and soak seeds of all the species of *Strelitzia* overnight or until they start swelling, before placing them in a seedling medium.



▲ Strelitzia reginae *seed capsule. Sunbirds pollinate* Strelitzia *species.*
▶ **top** *An uprooted* Strelitzia juncea *seedling showing the swollen roots that are characteristic of this genus;* **bottom** Strelitzia juncea *seedlings showing the complex venation on the leaves. A slight fertilizer deficiency manifests in the paler sections.*
▼ Strelitzia juncea *capsule split open ready to release seeds. Note the orange aril that is eaten by birds and mammals, which act as dispersal agents.*



TECTARIACEAE

Tectaria gemmifera produces numerous gemmae or bulbils on the adaxial surface of the lamina. When mature, these bulbils are shed and can be collected.

To propagate, place the bulbils on the surface of a suitable soil mixture. You can press them down into the medium slightly. Do not cover them, but keep the soil moist in a well-shaded position. These bulbils are quick to produce fronds.

▲ *Fern bulbils of* Tectaria gemmifera.

THYMELAEACEAE

I have had success with *Synaptolepis kirkii* by collecting the seed and germinating it in normal seedling mix. Remove the fleshy outer cover and sow the seed on the day after collection. It takes approximately 10 days to germinate. I have never tried to propagate this species from cuttings.

Yvette van Wyk at George in the southern Cape has attempted to root *Gnidia chrysophylla* from cuttings, but hasn't had any success. A reason why these cuttings do not survive may stem from added compost or fertiliser—nothing should be added to the soil. Furthermore, roots should be kept moist and plants should be planted back into the wild on cool, cloudy days.

TILIACEAE

Jute family

This group of plants is in my opinion one of the most widespread, productive families and supports wildlife on our continent. The adaptability of the genus *Grewia* allows it to inhabit every biome that you can think of, producing seed that is palatable to all types of fauna, including humans. It also provides cover for wildlife, while humans make use of the wood for all manner of tools and utensils, and for making fire.

Seed is the best way to cultivate this group. It either has a fleshy outer covering, which is eaten by animals to free the seed within, or it hides within a horny seed coat covered in bristles that prevent the seed from being eaten. The bristles hook onto fur and skin and aid dispersal of the seed. The shiny black seeds within germinate once the outer covering has been damaged or dropped. Examples of genera where seed is dispersed in this way are *Triumfetta* and *Sparrmannia*.

All these plants will germinate in a normal seedling mix after about 2–3 weeks. Seed should be sown at the beginning of the new growing season to achieve the best results.

▲ **left** Synaptolepis kirkii *fruit (Photo: Richard Symmonds);* **right** Grewia occidentalis *seedlings germinating in a tray.*

▲ **top** Tricliceras longipedunculatum *flower;* **bottom** Sparmannia ricinocarpa *fruit resemble* Ricinus *or Castor Oil fruit.*

Sparrmannia ricinocarpa and *S. africana* grow from cuttings. *S. ricinocarpa* is not a large shrub and cuttings should be taken from the previous season's growth, while *S. africana* will be able to grow from hardwood truncheons up to the diameter of a human forearm.

Turneraceae

The only plant in this family that I have had the pleasure of seeing is *Tricliceras longipedunculatum*. The capsules must be observed closely or else they split before you have time to blink. I suggest that the seed is sown immediately in shallow trays filled with sandy, humus-rich soil. It should take about 2 weeks to germinate if conditions are warm and sunny. Treat this plant like an annual and collect seed each season to enable new plants to grow during the following year. I have only seen it growing in disturbed places in the Kruger National Park and the Hluhluwe Game Reserve in KwaZulu-Natal.

Ulmaceae

Elm family

This family is best propagated from seed. I have had success with all the species of *Celtis* in South Africa, including *Celtis africana*, *C. gomphophylla*, and *C. mildbraedii*. The same applies to *Trema orientalis* and *Chaetachme aristata*.

Birds are stiff competition in collecting seed; hence planting these species is a must if one wants to attract birds to a garden. Once harvested, clean off the outer flesh and sow within a few hours. *C. mildbraedii* is covered by bright red flesh that is palatable. *Celtis* seeds germinate

within about 3 weeks. *Trema* seeds are tiny, approximately the size of half a match head. Clean the seed by rubbing it in an abrasive mixture of sand and water. Once cleaned, sow it in a tray filled with seedling mix. Germination takes 2–3 weeks. The outer flesh of *Chaetachme* is much firmer, necessitating rubbing it off on a stone, trimming it off with a sharp knife, or using a food blender. Germination takes 4–6 weeks. Leave the seedlings in semi-shade to develop quicker.

Celtis mildbraedii does not do well in full sun. Plant this species in the shade of another tree and trim the bigger tree after a few years to allow light in. I suspect that these plants prefer their roots to be cool and not baked like some of the other pioneer species.

Semi-hardwood cuttings of *Celtis mildbraedii* will root with the help of a rooting hormone mixture of 2,500 parts per million IBA and 1,250 parts per million NAA, mixed with a solution that consists of 1 part acetone : 1 part distilled water. Dip the cutting into the mixture and hold it there for about 3 seconds. Move the cuttings into the misting unit with bottom heat.

For more information, see Boon & Symmonds (2001).

VAHLIACEAE

The flowers are produced in leaf axils near the stem of this forb and the seed is like that of *Crassula*—fine and dust-like. It also seems from the notes on the labels of the herbarium specimens that I studied at the Natal Herbarium that these species occur in disturbed areas alongside roads and on riverbanks. Treat the seed the same as any of the other fine-seeded species.

See Chapter 2 for more information on fine seed.

VELLOZIACEAE

The best way to propagate species in the Velloziaceae is from seed. The plants inhabit rock plates in seasonally high rainfall regions and tend to flower at the beginning of the summer season, just as the new rains start. Seed is set quickly and ripens in about 6 weeks. Collect the fruit and when the capsules have split open, sow the seed on a seedling mix that is able to hold water. Water the seedlings from below, or leave the tray sitting in a bath of water. Seed germinates in about 2–4 weeks. Leave the seedlings in the trays for a season to get root-bound. Divide them just before the second growing season starts. Grow the seedlings in shallow soil or return them to the rock plates where they naturally occur.

I have been growing the South African *Xerophyta retinervis* in a shallow ceramic washbasin for about

▲ Celtis mildbraedii *fruit.*

▲ Xerophyta retinervis *unripe seed capsules.*

twenty years, never needing to re-pot it. It grows in association with *Cyanotis speciosa*, *Polystachya zuluensis* and the fern *Cheilanthes viridis*.

In KwaZulu-Natal, *Xerophyta retinervis* is the support plant for the epiphytic orchid *Polystachya zuluensis*. An interesting phenomenon is that the orchid flowers are the same colour tone as the *Xerophyta* flowers. The flowers of both plants present at the same height but at different times. I suspect that these two species have devised a pollination strategy with some local insect pollinator. I have experimented with *Polystachya tayloriana* from Kenya by attaching a piece to the stem of the *Xerophyta*, resulting in the orchid flourishing far better than if it were attached to an inert piece of wood. Now I am able to harvest seed from healthy *Polystachya* plants in cultivation.

Talbotia elegans is another member of this family and lives on seeps on cliffs. This species grows easily from cuttings or stems that are cut off and inserted into sharp river sand and makes excellent container plants. However, it needs a resting period during the dry winter months.

VERBENACEAE
Verbena family

This family can also be propagated from seed, provided it is collected before the local fauna gets hold of it.

I have found that semi-hardwood cuttings of the previous season's growth work best for this family. Soft tips will also grow, but it can prove complicated to keep these more delicate cuttings happy during a collecting trip, when they cannot be set in a mistbed straight away. Treat the cuttings with a rooting hormone, such as Seradix 2, and keep the soil or growth medium warm. Cuttings of *Lippia* and *Verbena* will take root within 3 weeks.

I have propagated the genus *Vitex* from seed only, but suspect that propagation from cuttings is also possible.

▲ *Unripe* Vitex amboniensis *fruits that are about 20 mm in diameter.*

special feature

Siphonochilus aethiopicus

by N.R. Crouch[1], M.C. Lötter[2], S. Krynauw[2] and C. Pottas-Bircher[1]

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Although quite a large family, with some 1,300 species, the Zingiberaceae is chiefly centred in Indomalasia. Sub-Saharan Africa is modestly endowed with approximately 100 ginger taxa in four genera, yet at its southern tip only a single species is indigenous, *Siphonochilus aethiopicus* (Schweinf.) B.L.Burtt (tribe Hedychieae).

The species is widespread in Africa, extending from KwaZulu-Natal in South Africa, north to Ethiopia and equatorial West Africa, and further west to Gambia. Plants are herbs with false stems up to 60 cm tall, and thickened aromatic rhizomes to which numerous tubers are attached. The leaves are radical, long, and tapering. The bisexual flowers are particularly showy; both these and the female flowers are produced at ground level directly from the rhizomes and are coloured white, yellow, and mauve.

Conservation status

In South Africa, *S. aethiopicus* is in danger of extinction following prolonged over-exploitation for the medicinal plant trade, despite being afforded legal protection.

Based on 1993 and 1999 census data, it is calculated that 5,064 plants are known to exist in the wild. The Red Data List assessment of *S. aethiopicus* for South Africa is accordingly determined to be Critically Endangered.

At a global level, the taxon is not considered to be threatened with extinction.

Protection of the last genetic reservoirs in southern Africa is inadequate; 65% of the remaining sites are outside established reserve or conservation areas, and remain vulnerable to exploitation. Such is their popularity that three of the six populations "protected" within reserves are

▲ *The bisexual flower of* Siphonochilus aethiopicus.

(Continued on next page)

still being heavily exploited. A total of 39 known populations could be traced, 44% of them still exist, 7% of unconfirmed status, and nearly half (49%) believed to be extinct.

The Mpumalanga Parks Board (incorporating the Threatened Plants Unit, Flora Sub-Section of the Transvaal Provincial Administration) has monitored the status of nine of these remaining populations and observed a 64% decline in numbers of individuals over the course of just four years. This finding confirmed earlier depredation observations made by Onderstall (1978).

Distribution

S. aethiopicus is widely distributed in savannah regions of its tropical African range, although Scott-Shaw (1999) reports on critically low numbers in most of these territories. In the late 1870's, Wood had found *Siphonochilus* growing at Inanda near Durban. So valued was this medicinal plant, that around 1900, the Basuto reportedly carried off pack horse-loads of the Inanda rhizomes to their mountain kingdom. It is believed that just such unsustainable utilisation has led to its almost complete disappearance from the natural flora of KwaZulu-Natal, where it has not been found growing in the wild for over 80 years.

Specimens may still occasionally be observed in the gardens of traditional medical practitioners. Such cultivation practices, locally in evidence since the 1880's, have fuelled doubts over its natural occurrence in the extreme south of its range.

Within KwaZulu-Natal, *S. aethiopicus* has historically been known from the Umhloti, Let and Umtwalume Valleys, and Inanda, Ongoye, Hlopenkulu, Dumisa and Umbambasa. A report on its present occurrence at Lusikisiki in Pondoland, Eastern Cape, may relate to the recorded trade of Wild Ginger to that region from Inanda in about 1880.

Ethnobotany in southern Africa

The **Zulu** know this ethnomedicinal (*muthi*) subject as *indungulu*, *isiphephetho* or *ithole*. They use the rhizome in a cough and cold remedy, in tonics, and in treating hysteria.

Plants are also grown as protective charms about Zulu homesteads based on the belief that they confer protection against lightning and snakes.

Webb and Wright (1979) recorded that historically the plant was used in summer by the Zulu to ward off lightning (presumably as a cultivated charm), and taken in winter to treat fevers. Conversely, this magical plant is considered to precipitate crop failure for those who dare cross their garden whilst holding it, and to attract lightning to those who chance harvesting it during its non-dormant (summer) state.

The Zulu and Sotho used a cold infusion of the rhizome for horse-sickness, although it has never been clear whether this was in a prophylactic or curative sense. The rhizome is also said to induce stupor in the horse.

Watt and Breyer-Brandwijk (1962) reported on its use by the Swazi as a malarial remedy and for the relief of menstrual pain, for which purpose the rhizomes were chewed. The Swazi know the plant as *isithungulu* or *sithungula*. Elsewhere in the region, rhizomes have been employed in the treatment of rheumatism, toothache, neuralgia, and to decongest nasal passages . Herbalists report that plants protect them from the toxic effects of some of the plants they harvest. In conjunction with *Alepidea amatymbica* (Apiaceae), a medication for abdominal cramps and colic is prepared.

The cultivation of Wild Ginger for its magical properties has served to conserve something of the remaining genetic diversity, albeit *ex situ*. The Xhosa of Idutywa (Eastern Cape) use the powdered roots of *iszphephetho* to ward off evil spirits.

Siphonochilus aethiopicus is one of the first South African medicinal plants to have been recorded in trade. In 1910, Burtt Davy described the traffic in dried rhizomes from what is today Mpumalanga to Gauteng. Likewise, Wood and Franks (1911) reported on the export of material from Inanda near Durban to the Eastern Cape, and to what is today the neighbouring country of Lesotho.

An international trade in *Siphonochilus* continues to supply plants to the Durban *muthi* markets. It is rated as one of the ten most popular items out of some 450 species in local commerce. In a parallel study, Mander (1997) ranked *Siphonochilus* alongside *Alepidea amatymbica* as the most popular medicinal plant in Mpumalanga.

Wild Ginger traded in Mpumalanga procured locally, whereas rhizomes sold in the Durban *muthi* markets originate in Mpumalanga, Limpopo, Swaziland, as well as Mozambique. This demand has affected Swaziland's rare and localised stocks significantly, leading to voiced concerns. The increasing overall scarcity of rhizomes has been reflected in the near tripling of Wild Ginger's retail value during the 1970s. Much of the material appearing in Durban is now grown on a small scale by rural farmers in the Eastern Cape, although it is rarely available and highly priced (R5–R10 per rhizome).

It was found that in Limpopo, only the larger rhizome section from the previous season's growth was harvested; the rest of the rootstock was discarded. This selection process possibly relates to high concentrations of efficacious constituents in particular organs. Elsewhere in Africa, the rootstock is used in ethnomedicine, but additionally employed as a spice. In this regard, it is reputed to have the sharp taste of real ginger.

▲ Siphonochilus aethiopicus *in cultivation in Durban, South Africa.*

Pharmacology

In a recent pharmacological study, researchers tested a number of medicinal plants used in the treatment of pain and inflammation. In an assay which considered the ability of materials to disrupt the inflammation process, extracts of *S. aethiopicus* leaves were found to exhibit higher inhibitory activity than indomethacin, a standard pharmaceutical drug used as an anti-inflammatory. One wonders how much more active rhizome extracts would be, given that these organs are the parts used in traditional medicine. What these findings indicate, though, is that leaves could possibly be substituted for rhizomes, so allowing for more sustainable harvesting of limited materials. This *in vitro* anti-inflammatory activity validates the traditional use of plants in treating pain and body swellings, and in treating dysmenorrhoea.

Propagation

The most efficient way of propagating this species is by vegetative means, given that the seeds develop and mature underground, and accordingly are difficult to find. Fruit-set is typically poor for this species, and when it does occur, the seeds germinate *in situ*, the seedlings penetrating through the decaying fruit walls. These progeny are reportedly susceptible to damping-off. Even when recovered and sown, seeds may take a year to germinate. Propagation through either simple splitting of rhizomes in late winter, longitudinal sectioning of rhizomes or through tissue culture is recommended for bulking-up purposes.

Tissue culture

Essentially the same procedure as used for micropropagating *Zingiber officinale* has been followed.

Rooting of shoots was best initiated *in vitro*, on an auxin-containing medium. Before hardening-off under nursery conditions, plantlets were rinsed under running tap water to remove the agar medium. They were then planted in clumps of four or five in punnets, with a planting mixture of bark and polystyrene (3:1), each clump covered with an inverted bottle. During winter, bottom heating was applied. After one month, the bottles were removed, but the plants were kept under intermittent mist for two weeks.

Cultivation

It would be logical to cultivate *Siphonochilus* in previously known Wild Ginger areas—co-incidentally, the same region where commercial ginger is currently grown. These are the lower-lying, warmer, and more humid parts of the Mpumalanga Lowveld and KwaZulu-Natal's warm subtropical east coast. He suggests that the soil should be loose, friable, and well drained. Nichols also suggested that trenches be dug and filled with compost (as one would do

◀ Siphonochilus aethiopicus *fruits.*

(Continued on next page)

when growing commercial ginger) to encourage good root growth. This would further ensure that larger, better-formed rhizomes are produced, with many new "eyes" to split off at the end of the growing season, for propagation purposes. He found that plants responded well to high levels of organic matter in the form of sludge in the sandy, highly leached soils found in Durban.

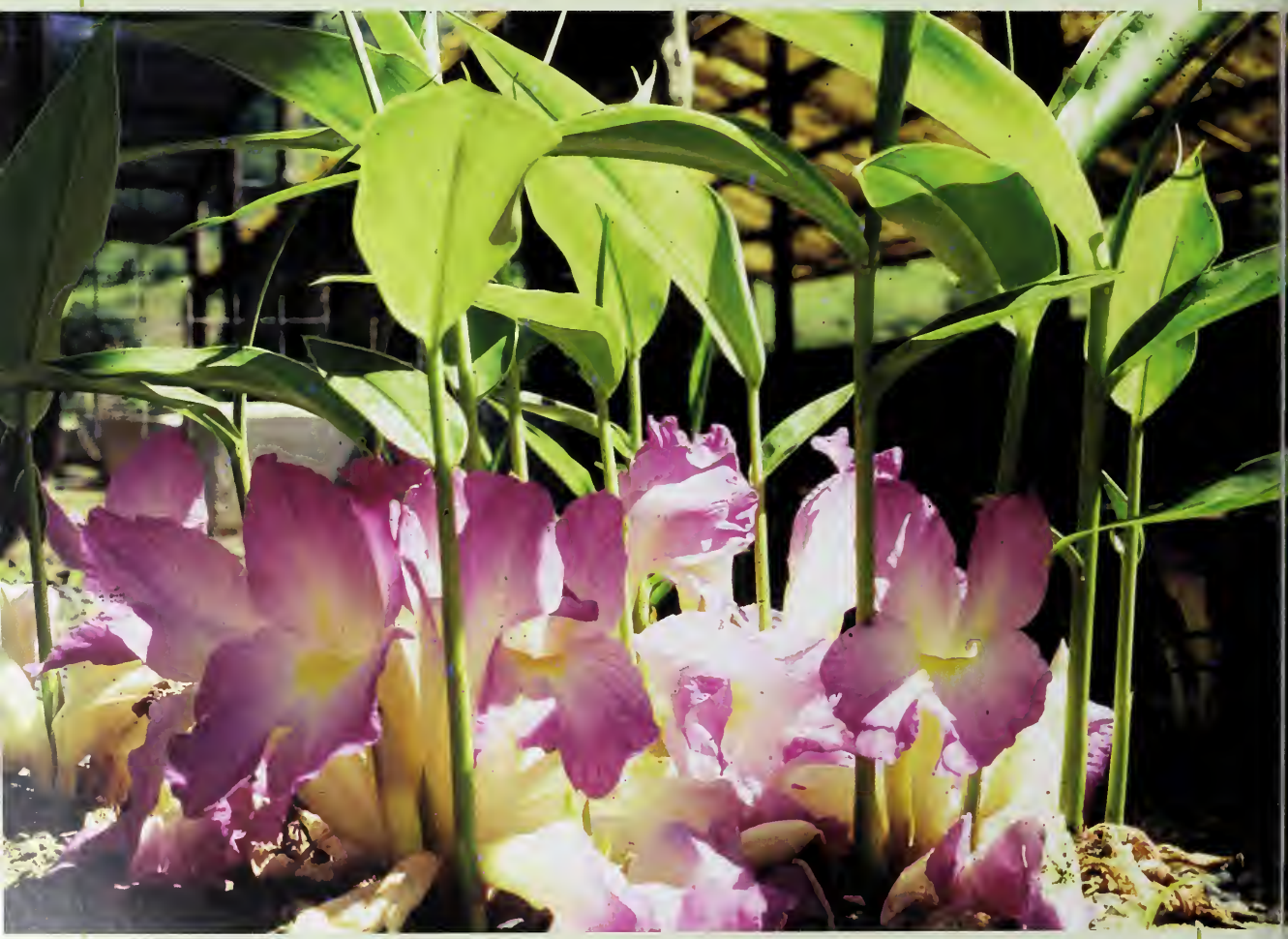
De Lange *et al.* (1991) recommended soils with a high water holding capacity. For optimal rhizome development, they recommended that the topsoil be at least 250 mm deep. De Lange *et al.* (1991) suggested that that the rhizome pieces should be planted on ridges, the most desirable planting time being late winter or early spring. In line with soil preparation for commercial ginger cultivation, these authors recommended the application of 70 tonnes/ha kraal manure or 24 tonnes/ha chicken manure. McCartan *et al.* (1999) confirmed the high feeding requirement of *Siphonochilus*, and reported a five-fold increase in rhizome yields per hectare when soils were compost-enriched. They further determined that a high density planting (spaced 15 x 15 cm) was more profitable than a lower one (spaced 30 x 30 cm). A maximum rhizome yield was obtained when using small rhizome propagules rather than larger ones.

Pests

Grasshoppers and other insects have been observed eating the leaves of wild plants in the northern provinces. Nichols (1989) has never observed pests or diseases afflicting *Siphonochilus aethiopicus* in cultivation. However, nematode and other infestations to which *Z. officinale* is prone need to be looked out for, as it is not known to what extent Wild Ginger is susceptible to such infestations. Significantly, in following the micropropagation protocol of De Lange *et al.* (1991), all original planting material would likely be nematode-free.

Harvesting

In southern Africa, the optimal harvesting period would be during winter (June), following the onset of dormancy. The rhizomes should be lifted and stored during winter and subdivided and planted in late winter or early spring. Nichols advised that when splitting the rhizomes, not all tubers should be detached. He considered that these organs serve as water and nutrient reserves providing for flower and leaf production in the subsequent season. Security might be important considering its popularity and market value as an ethnomedicinal plant.■



▲ Siphonochilus aethiopicus *plant in flower.*

VIOLACEAE
Violet family

This family propagates well from seed. The trees of the genus *Rinorea* grow in dense, single-species stands in forests. Observe the trees and wait until the fruit is ready for harvesting. Collect as many seeds as possible from as many trees as possible. Clean the seeds from the outer husk. Remove the seed from the thin fleshy aril and sow immediately on a well-drained, humus-rich seedling mix. I often add some leaf litter from under the parent trees to give it a boost. Seed germinates within days and can be pricked out in about 1–2 months.

We have a moderately restricted population of *Rinorea ilicifolia* in the Hlathikulu or Gwalaweni Forest on the Swaziland border in northern Maputoland. These plants grow well from seed that germinates within a week from sowing.

I have never attempted to propagate this species from cuttings.

VISCACEAE
Mistletoe family

The mistletoes are difficult to establish, because they are parasites and consequently need to attach to a living host plant.

These plants offer a good example of the importance to observe specimens in the wild, providing guidance as to how one should go about *ex situ* propagation. See which tree is the main host in the area. Check the diameter of the branch that the *Viscum* is attached to. *Viscum* seedlings need to be able to penetrate the conducting tissues of the host to survive. If the bark is too thick, the seedlings cannot survive. On the other hand, the bark may be too thin, raising the chance that the host will shed it.

▲ **top** Rinorea ilicifolia *fruit showing seed within;* **bottom** Rinorea ilicifolia *fruit and leaves.*
◀ Viscum *sp. in fruit.*

One method is to grow the correct host plants in containers and attach the *Viscum* to the young plants. Another method is to attach *Viscum* seed, which has been squeezed out of its fleshy outer covering exposing the sticky gum, to the correct-sized branch of a suitable host in its natural habitat. I have done this very successfully in our local area with *Viscum rotundifolium*. (Anon, Royal Horticultural Society, 1998; Visser, 1981).

For a more detailed account of this group, refer to "Mistletoes of Africa" by Roger Polhill and Delbert Wiens, published by the Royal Botanic Gardens in Kew in 1998.

VITACEAE
Grape family

Members of this family, including *Cyphostemma* and *Cissus*, grow from cuttings in the growing season, provided they have been allowed to dry out for about two weeks. Lay the climbing species in a bed of sand for the stems to take root. Take the cuttings at the beginning of the new rainy season.

Propagation from seed is easy and quick. Make sure that the desert species are able to rest during the dry, dormant period. This period is different in the different countries where these species may occur. Collect a minimum of five different plants to obtain a better genetic spread in the collection.

WARNING

Do not attempt to clean the seeds by chewing off the flesh, as the fruit of many of these species contain crystals that produce a very unpleasant reaction in the mouth and throat.

ZAMIACEAE
Cycad family

Encephalartos is best propagated from seed. Seed viability can be established by the flotation test—healthy, fertilised seeds drop to the bottom—although I have had mixed results with this method of testing. Rather sow all the cleaned seed and keep monitoring until most have germinated. This could take up to 6 months. The seed must be kept warm and in the light for best results.

Another way of propagating the genus *Encephalartos* is with suckers, also called offsets or "pups". A classic

▲ **top** Encephalartos ferox *seedlings germinating;* **bottom** *Female cones of* Encephalartos *sp. with suckers growing from the central core of the cone. (Photo: Sharon Louw)*
◀ Cyphostemma flaviflorum *in seed.*

example is *Encephalartos woodii* where the only known plant is male. This species is propagated solely by removing and growing "pups"—it is reportedly extinct in the wild. It was endemic to the Ngoye Forest in KwaZulu-Natal, South Africa. Remove the "pups" when the new growths have a stem of about 100 mm in diameter. Set these in a sandy, compost-rich soil in semi-shade until new roots have developed. Rooting can take up to 6 months. Remove offsets at the beginning of the growing season. Some people remove the leaves of these offsets, but I always leave them on and the plants seem to develop just fine.

Ex situ propagation and cultivation are a concern because of the localised nature of some of the more rare species and the need to keep the wild population intact. Despite stringent laws, these plants attract collectors and we are still unable to protect these plants adequately.

Encephalartos are subtropical and will not survive in cool climates, unless they are grown in a glasshouse.

ZINGIBERACEAE
Ginger family

Siphonochilus aethiopicus is regarded as rare in South Africa and Swaziland. It was one of the first medicinal plants that I ever tried to propagate. It was also my first encounter with how tissue culture can bulk up your stocks rapidly and allow you the luxury afterwards of propagating many more plants by conventional methods. Dr Hannes de Lange and Prof. Kobus Eloff made the initial breakthrough, using cultivated ginger methods at Kirstenbosch. (De Lange, 1989; Crouch & Symmonds, 1998; Crouch *et al.*, 2000; McCarten *et al.*, 1999).

I was involved with the first effort of cloning *Siphonochilus aethiopicus* in the late 1980s when I sent material to Kirstenbosch. Hannes de Lange, researcher at Kirstenbosch, used the protocol that he developed for commercial ginger (*Zingiber officinale*) on our native ginger and it was successful. He was then able to produce many thousands of plants for us in the Durban Parks Department. We used the same recipe and continued to grow thousands of plants for ourselves. The plants we were producing of one or two clones were being grown and harvested for the traditional medicine trade. Growing clones was not a problem.

If our mission were to save this plant from extinction, however, we would have failed dismally, as we did not have a wide range of genetic material that would enable us to reintroduce the plant into the wild. These plants would not have been able to seed freely, lacking a whole range of pollen types to choose from. This would have led to pollen incompatibility problems.

ZYGOPHYLLACEAE
Caltrop family

As a grower living in the subtropical part of Africa, this is a family that I am not familiar with at all. Ernst van Jaarsveld at Kirstenbosch is very definite in his opinion that propagation is not possible. If advice is needed, I suggest that *Zygophyllum* seed is sown when the growing season starts and that habitat soil is mixed into the seedling mix as an inoculant to ensure the best possible chance at success.

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Glossary

Abbreviations
adj.—adjective
n.—noun
pl.—plural
sing.—singular
syn.—synonym
v.—verb

A

Abaxial off or away from the axis; (of the surface of a leaf etc.) initially facing away from the stem. The underside of a frond.

Adaxial toward the axis; (of the surface of a leaf etc.) initially facing toward the stem.

Adventitious formed in an unexpected place anatomically; (of roots, buds, etc.) arising from a part other than that usual in plants generally, or at an unusual time of development.

Angiosperm a plant which bears its seeds enclosed in a seed-vessel, that is, a flowering plant.

Apex the growing point of a shoot etc. The tip, or distal end of an organ, usually of a leaf or fruit.

Articulated place of separation.

Aquatic growing or living in or near water.

Aril an additional envelope, often fleshy, developed around the seed in certain plants, evolved mainly to attract birds and insects, which then distribute the seed, for example, *Commiphora*, *Cnestis* and *Trichilia*.

Axil the upper angle between a leaf surface and the stem which bears it; also the angle between a leaf midrib and the side or lateral veins.

B

Basal at the base.

Bisexual having both male and female sexual organs in a single flower. Compare unisexual.

Bract a leaf, often modified or reduced, which subtends a flower in its axil, sometimes brightly coloured, for example *Poinsettia*.

Bud a rudiment of a shoot, leaf, or flower.

Budding a mode of propagation in which a bud from one plant (scion) is inserted under the bark of another (stock).

Bulb the globular underground organ of an onion, lily, or similar plant, which contains the following year's bud and scale leaves that serve as food reserves. Also, a plant growing from a bulb.

Bulbil a small bulb or bulb-like organ, often produced above ground, such as in the axil of a leaf, which when detached, is able to propagate a new plant.

Bushveld a colloquial term of South African origin to denote any vegetation type composed of both trees and grasses, often with shrubby thicket.

C

Callus (*pl.* **calli**) an outgrowth of tissue formed to cover a wound or cut, or at the base of a cutting.

Calyx the outer whorl of a flower, made up of a number of sepals (calyx lobes) which protect the flower in bud. Collective term for all the sepals of a flower; usually green.

Cambium a thin layer of cells that occurs within the stem and roots, which divides to form permanent tissues. In higher plants, the cambium lies between the wood and the bast, adding elements to both, namely wood (xylem) on the inner, and phloem on the outer.

Canopy the branches and leaves of a tree, also known as the crown; a term usually applied to the top or upper layer of a forest.

Capillary action the force of attraction of a very thin tube (capillary) or minute space on a liquid, which acts to suck the liquid into that space; part of the means whereby water moves in the xylem and in soil.

Capsule a dry fruit comprised of more than one carpel; may be indehiscent (not splitting open) or dehiscent (splitting open). A dry seed-case, which opens when ripe by the parting of valves.

Carnivorous plant a plant that is capable of catching and digesting small creatures such as insects.

Caudex a woody swollen or succulent stem that is either above or below ground in a plant. See suffrutex.

Chlorosis loss of colour; blanching of normally green tissues, or the turning green of petals, as in a green rose.

Chlorotic pale yellow; suffering from chlorosis.

Clonal seed seed produced from plants of one clone.

Clone a group of plants that have been vegetatively propagated from a single parent, which therefore have identical genes.

Commensal an association between two species in which one benefits and the other is neither harmed nor benefited.

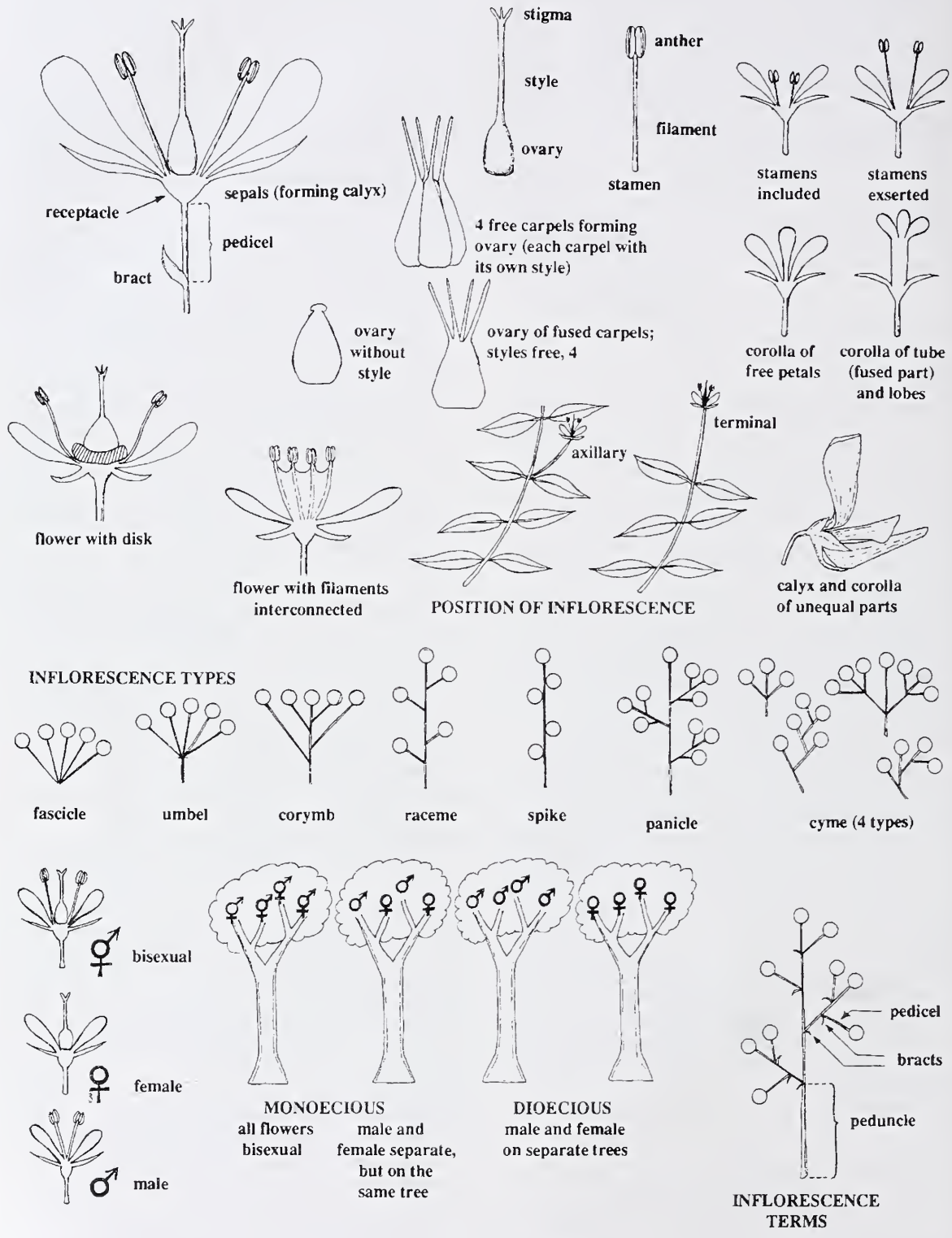
Cone fruit of a pine or cycad, with scales.

Coppice the young, vigorous shoots produced from the base of a tree trunk in response to it being damaged or felled, or from damaged roots. Compare sucker.

Coppicing the periodic cutting-back of trees to or near the ground, which then are replaced by regrowth from suckers arising from the stump. Some trees, for example, many Eucalypts, *Hibiscus*, and *Acacia*, are especially adapted to coppicing. Compare pollarding.

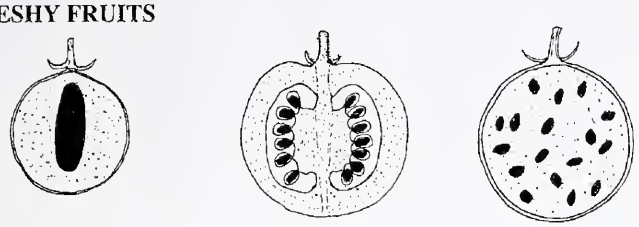
Corm a tuberous bulb-like rootstock.

Cotyledon the first leaf, or pair of leaves, of a plant,

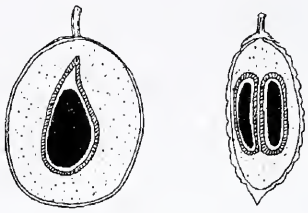


(Illustration from Beentje, 1994.)

FLESHY FRUITS



Berry
No hard layer; 1-many seeded



Drupe
1-several seeds, each surrounded by a stony layer

DRY FRUITS - INDEHISCENT (not splitting open)

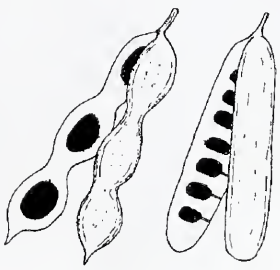
Achene
Small, single-seeded

Samara
Winged achene

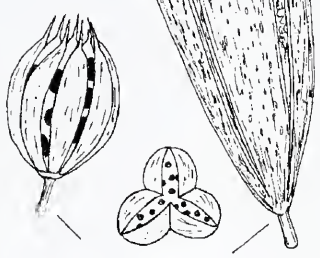
Nut
Single seeded, with woody outer layer

DEHISCENT FRUITS (splitting open)

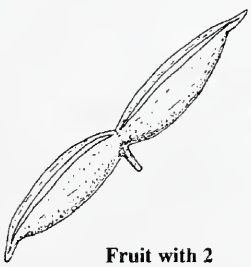
Follicle
Splits on one side



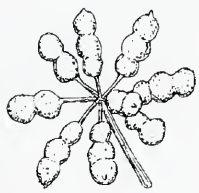
Legume
Splits into 2 valves



Capsule
Splits into several valves; dry

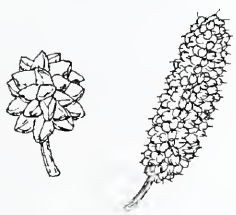


Fruit with 2 mericarps



Fruit with many monocarps

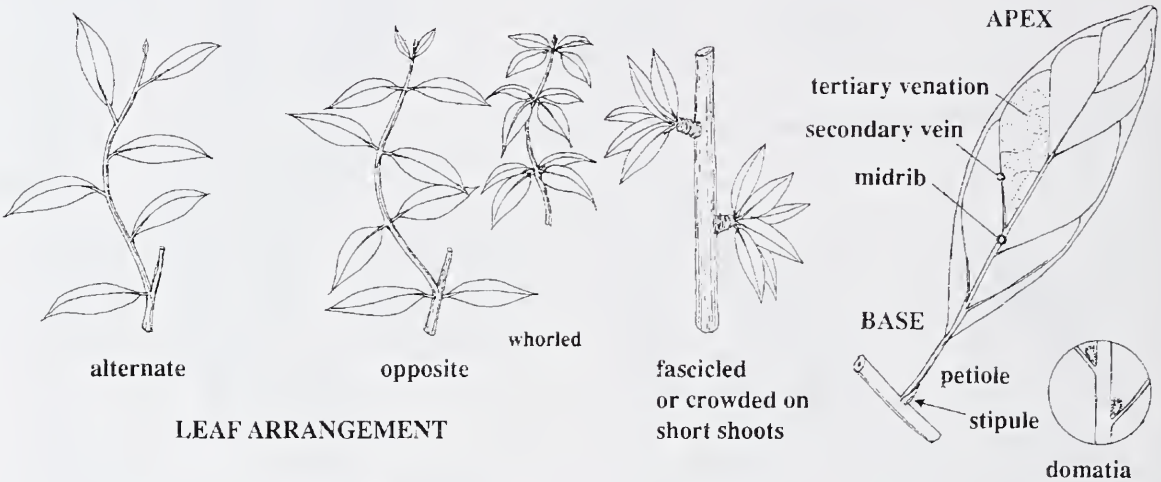
Monocarps and mericarps originate from a single flower



Fruit syncarpous
originate from many flowers close together

GENERAL TERMS

(Illustration from Beentje, 1994.)



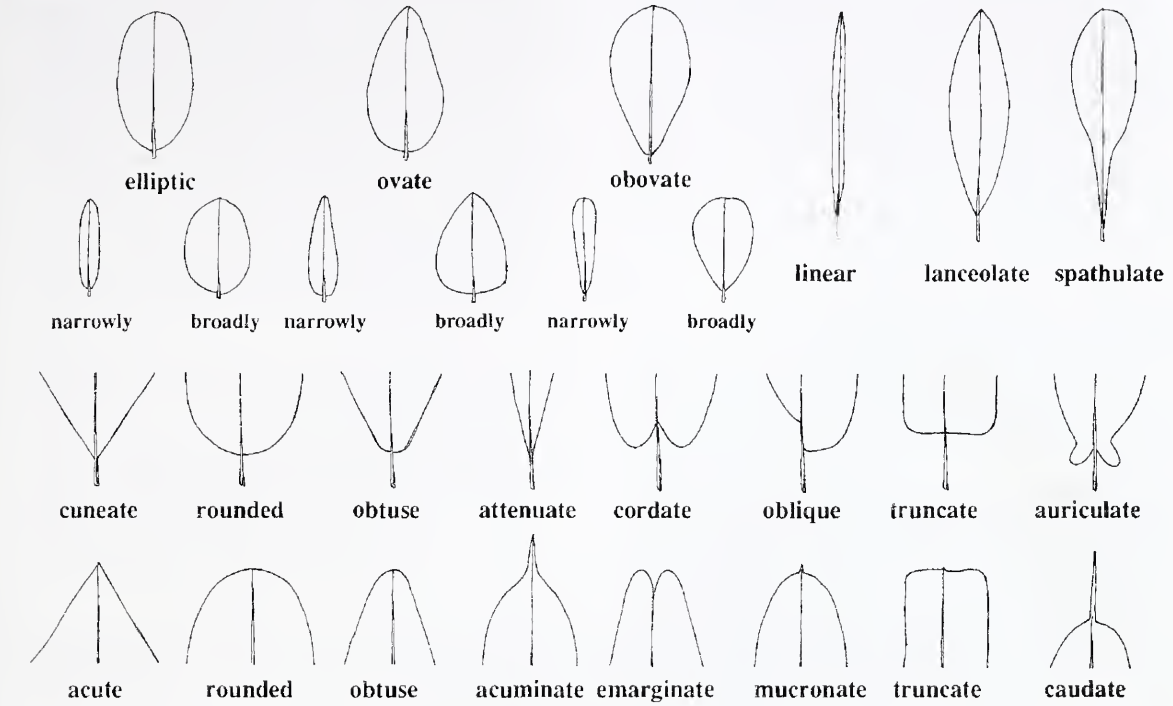
LEAF ARRANGEMENT

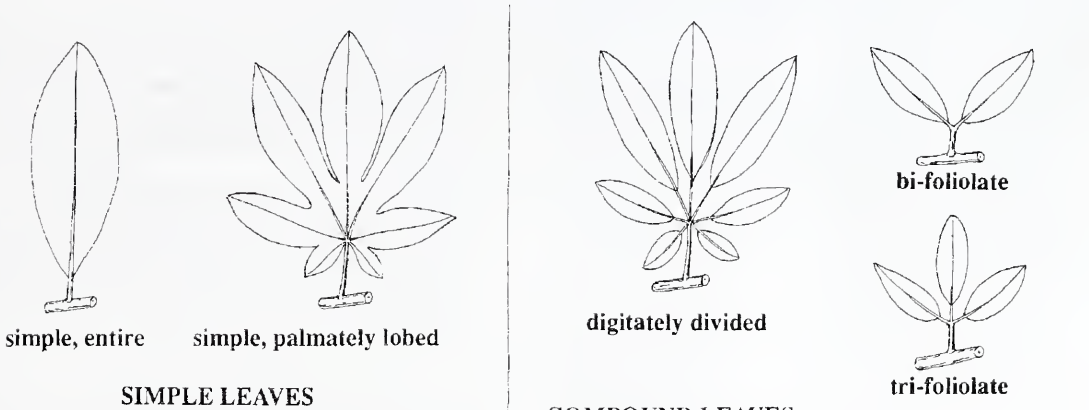
HAIRYNESS (much enlarged)

LEAF MARGINS

(Illustration from Beentje, 1994.)

LEAF SHAPE





(Illustration from Beentje, 1994.)

either remaining within the seed coat (testa), or rising above the ground on germination. Compare dicotyledon and monocotyledon.

Cross-pollination fertilisation of the flower(s) of one plant by pollen from another plant. Compare self-pollination.

Crown the leafy head of a tree or shrub.

Cryptogams any plant of the Linnaean division Cryptogamia (now disused), which embraced all non-flowering plants, as ferns, mosses, algae, fungi, etc. (Opposite: phanerogam).

Cutting a piece of root or stem, either taken from the tip, or from the harder wood below; used to propagate a new plant. Compare strike.

D

Deciduous the seasonal shedding of leaves, in winter in cold countries, or at the beginning of the dry season in the tropics (where it is uncommon).

Dehiscent splitting open to release seeds, pollen, or spores.

Dicotyledons a plant whose embryo has two cotyledons.

Dimorphic of different shapes and functions.

Dioecious with unisexual flowers, the male and the female flowers on separate plants. Compare monoecious.

Distal situated away from the centre of the body or the point of attachment; further, more distant.

Dormant resting, not in active growth; usually in plants which are deciduous.

E

Ebracteate without bracts.

Ecology the branch of biology that deals with organisms' relations to one another and to the physical environment in which they live; (the study of) such relations as they pertain to a particular habitat or a particular species.

Economic botany the study of the uses of plants and their products.

Economic plants plants which are of use to man, either directly or indirectly, as distinct from plants which are merely ornamental.

Embryo the part of the inside of a seed which develops into a plant.

Endemic of a plant or animal native to, and especially restricted to, a certain country or area. Compare indigenous.

Epiphyte (*adj.* **epiphytic**) a plant (especially one that is not parasitic) which grows on another plant for support, generally not attached to the ground, for example, many orchids and some ferns.

F

Family group of genera resembling each other in various characteristics, and, in plants, given a scientific name with the suffix -ae or -aceae.

Flagging see wilting.

Flush the periodic production of copious young shoots; a sudden rise of sap after a dormant period.

Follicle a many-seeded dry fruit, derived from a single carpel and splitting down one side, for example, one lobe of a pod of *Sterculia*.

Forb any non-woody plant other than a grass, sedge, rush, etc.

Forest a vegetation type composed primarily of large trees which have overlapping canopies, under which are characteristically a small tree layer, a shrub stratum and a herb layer. Compare woodland.

Fungi (*sing.* **fungus**; *adj.* **fungal**) any of a large division of organisms, including mushrooms, toadstools, moulds, rusts, yeasts, and constituents of lichens, which lack chlorophyll, and grow on and obtain nutriment from organic matter. Also collectively, a growth formed by such organisms.

G

Gamete a mature haploid germ cell (male or female) which unites with another of the opposite sex in sexual reproduction to form a zygote.

Gametophyte in the alternation of generations, the gamete-producing phase in the life cycle of a plant (the dominant form in bryophytes) which forms the zygote from which the sporophyte arises.

Genes units of biological material (DNA) which are passed on from generation to generation.

Genus (*pl.* **genera**) a group of closely allied species. The generic name forms the first part of the scientific name of any species.

Geocarpic a plant that produces it fruits underground, like peanuts and *Cucumis humifructus*.

Gland any of various (groups of) cells on or within a plant structure which secrete some particular substance or substances (e.g. oils, nectar, resin, or water).

Grassland a vegetation type dominated by grasses. When a quantity of trees is present, it is termed wooded grassland.

Gymnosperms a woody plant belonging to the Gymnospermae, one of the two main divisions of seed plants, lacking flowers and with seeds unprotected by an ovary or fruit, and including conifers, cycads, and ginkgos.

Gynoecium the female part of an angiosperm flower.

H

Habit the characteristic mode of growth; the form and shape of a plant.

Habitat the environment in which a plant lives.

Haploid (of a cell) containing a single set of unpaired chromosomes.

Herb a general term for medicinal or culinary plants, which may or may not be woody. A plant whose stem does not become woody and persistent (as in a shrub or tree).

Herbaceous garden (or border) a section of the garden devoted to herbaceous plants, usually planted in a systematic order.

Herbaceous resembling a leaf in colour or texture. With non-woody stems as opposed to woody stems. Opposite scarious.

Herbarium a collection of dried plant specimens, mounted on sheets of paper and systematically arranged and named. Also, a room or building housing such a collection.

Host an organism on which a parasite lives and by which it is nourished (also applied, loosely, to a plant supporting an epiphyte).

Humus the organic constituent of soil, formed by the decomposition of plant materials.

Hybrid a plant produced as a result of cross-pollination of two different species.

I

In situ in position; sowing or planting where a plant is intended to remain at maturity.

Incompatible plants between which hybrids cannot be formed.

Indehiscent not dehiscent, not splitting open to release the seed.

Indigenous native to; belonging naturally to (a particular area, country, etc.). Compare endemic.

Inflorescence flowering part of a shoot, including stem, flower(s) and bracts.

Invasive tending to intrude upon the domain of another; spread into.

K

Kernel softer (often edible) part within hard shell of a nut or stone fruit; body of seed within husk, for example grain of wheat.

L

Lamina the thin, flat blade of a leaf or petal.

Larva (*pl.* **larvae**) an insect in a state of development (displaying little or no similarity to the adult) lasting from the time of its leaving the egg until its transformation into a pupa.

Latex a milky liquid found in many plants, for example, of the Moraceae, Euphorbiaceae, Apocynaceae families, which exudes when the plant is cut and coagulates on exposure to the air. The latex of *Hevea brasiliensis* or other plants is used to produce rubber.

Layer a shoot fastened down and partly covered with earth to take root while still attached to the parent plant.

Layering the rooting of a branch while still attached to the parent plant by natural or artificial means. Bend down a layer to the ground and cover it partly with earth to take root and propagate the plant.

Leaflet a separate unit of a compound leaf.

Legume (*adj.* **leguminous**) any plant belonging to the large family Leguminosae (in recent times usually broken down into the families Mimosaceae, Caesalpiniaceae, and Fabaceae), characterised by their potential to fix atmospheric nitrogen into the soil; also a colloquial term applied to plants with a bean-like pod.

Lianas or **lianes** woody, climbing vines, with rope-like stems common in wet tropics.

Lichen any of a large group of composite organisms formed by association of algal cells with a fungus, and occurring as encrusting or branching friable growths on surfaces, to which they give a green, grey, or yellow colour; originally, a liverwort. Also collectively, such organisms growing as a crust or clump.

Lignin a cross-linked phenolic polymer which combines with cellulose to give woody plant tissue its rigidity.

Lithophyte (*adj.* **lithophytic**) (**=epilithic**) a plant that grows on rocks.

Lobe a (chiefly rounded) projection or division of a leaf, petal, or other organ of a plant; especially one extending less than halfway to the centre. Formerly also, a pod, a capsule.

M

Monocotyledons plants with one cotyledon or seed-leaf, the true leaves also being usually parallel-veined, not net-veined as in most dicotyledons; one of the two subclasses of angiosperms.

Monopodial (of growth) with a persistent terminal growing point producing many lateral organs successively (compare sympodial).

Monopodium a single continuous growth axis which extends at its apex and produces successive lateral shoots.

Montane of, pertaining to, or inhabiting mountainous country; specifically, designating or pertaining to the belt of upland vegetation below the tree line.

Meiotic cell division in which the number of chromosomes in the daughter cells is half that of the parent cell—usually leading to the formation of spores.

Mitotic cell division in which the number of chromosomes in the daughter cells is the same as that of the parent cell.

Mucilage (*adj.* **mucilaginous**) a polysaccharide substance extractable as a viscous or gelatinous solution in water from roots, seeds, and other parts of certain plants, and used in medicines and adhesives.

Mycorrhiza a symbiotic or slightly pathogenic fungus growing in association with the roots of a plant, either on the surface or within the cortex.

N

Node the point on a stem where the leaf or leaves emerge.

Nucellus the central part of an ovule in which the embryo plant is generated.

Nucleus the kernel of a nut or seed; the nucellus of an ovule.

O

Offset a short lateral shoot, especially from the lower stem, bulb, or corm, of a plant, serving for propagation.

Organic (a) of, pertaining to, or designating carbon compounds, (originally, those naturally existing as the constituents of living organisms or derived from such compounds); containing carbon in combination. (b) (Of a fertilizer) produced from (only) natural substances; (c) (of farming, gardening, etc.) involving the growing of plants without the use of artificial fertilizers, pesticides, etc.; (d) (of food) produced without the use of such chemicals.

P

Parasite an animal or plant which lives in or on another and draws its nutriment directly from it, harming it in the process. Compare commensal, symbiosis; epiphyte, saprophyte.

Pathogenic causing disease.

Perennial of plants, their roots, etc., remaining alive through a number of years; specifically designating herbaceous plants which die down to the root and shoot up afresh every year. Also remaining green or leafy throughout the year, evergreen.

Permanent wilting point the soil moisture content at which plants wilt and fail to recover turgidity when water is added.

Petiole the stalk of a leaf. If absent, the leaf is sessile.

Phloem one of the two chief components of a vascular bundle, which conducts synthesized food downwards from the leaves.

Photosynthesis the process in plants by which carbon dioxide is converted into organic compounds using the energy of light absorbed by chlorophyll, which in all plants except some bacteria involves the production of oxygen from water; any photochemical synthesis of a chemical compound.

Phyllopodium (*pl.* **phyllopodia**) a leaf-like frond that forms on the rhizomes of some ferns that is flattened and takes on the photosynthetic functions of a normal leaf/frond. Especially in the genera *Platycerium* and *Drynaria.*

Pistil the unit of the gynoecium.

Pod a (long) seed-vessel, especially a dry and dehiscent one; specifically that of a leguminous plant, a legume.

Pollarding lopping or removing the crown of a tree, at some height above the ground, as of shade and roadside trees, which afterwards send out new shoots or branches. Compare coppicing.

Proliferous buds bearing plantlets.

Propagation reproduction of new individuals, by sexual or asexual means.

Prothallus a minute cellular disc or thallus produced by the germination of a spore. Also, the female gametophyte of a gymnosperm.

Pulp the fleshy or succulent part of a fruit.

R

Rachis (*pl.* **rachides**) (=**rhachis**) the main axis of a compound leaf (especially the frond of a fern) or of an inflorescence in which flower stalks occur at short intervals from each other, as in Poaceae.

Resin any hard, sticky, flammable, frequently aromatic substance containing organic polymers and terpenoids, secreted by various trees and other plants, often extracted by incision especially from fir and pine, and, unlike a gum, insoluble in water.

Rhizome (*adj.* **rhizomatous**) a continuously growing, usu. horizontal, underground stem, which puts out lateral shoots and adventitious roots at intervals, always distinguished from a true root by the presence of buds, leaves, or scales.

Rootstock (a) a rhizome; especially a short erect rhizome or underground stem from which new leaves and shoots are produced annually; (b) a stock on to which another variety has been grafted or budded.

Ruderal (*adj.*) growing on waste ground or among rubbish.

Runner a long creeping stem arising from an axillary bud, which roots at the nodes and forms new plants. Compare stolon.

S

Sapling a young tree.

Saprophyte a plant that derives its nutriment from decaying organic matter.

Scandent having a climbing habit.

Scarify make scratches or slight incisions in; cover with scratches or scars. Hurt, wound. Make incisions in the bark; remove surplus branches from.

Scion a shoot or twig, especially one cut for grafting or planting.

Scrambling plant a plant with a creeping, spreading habit, usually anchored with tendrils, hooks, or thorns.

Seedling a young plant raised from seed, as distinct from a grafted or budded plant or a rooted cutting.

Self-pollination pollination occurring between flowers of the same plant, or within the same flower. Compare cross-pollination.

Self-sterile not self-fertilizing.

Sessile attached directly to a surface; having no stalk. Also, having stalkless fruit.

Shrub stratum the layer in a forest or woodland below the tree canopy which is dominated by shrubs.

Shrub a woody, perennial plant with two to several stems arising from near the ground; compare to a tree.

Species the basic unit of biological classification; a group of individual plants resembling each other by a combination of constant characteristics, with inter-breeding possible within the species, but generally not between species.

Spine a stiff sharp-pointed outgrowth arising especially from the wood of a plant; specifically one that represents a modified leaf, part of a leaf, or stipule. Compare thorn.

Spore a small, usually one-celled, reproductive unit capable of giving rise to a new individual without sexual fusion, characteristic of fungi. Compare gamete.

Sporophyte the fern plant.

Stamen the male reproductive organ of a flower.

Stigma that part of the pistil in flowering plants which receives the pollen in impregnation, very varied in shape, and situated either directly on the ovary (sessile) or at the summit (more rarely, the side) of the style.

Stock the trunk or woody stem of a living tree or shrub (as opposed to the root and branches), esp. one into which a graft is inserted.

Stolon a long horizontal side-stem of a plant that roots at the tip to form a new plant. Originally, a sucker. Compare runner.

Stoloniferous producing stolons, spreading or reproducing by means of stolons.

Strike send down or put forth (a root or roots); cause (a cutting etc.) to root.

Style a narrowed frequently elongated projection of the ovary, bearing the stigma.

Succulent having thick fleshy leaves and/or stems adapted to storing water.

Sucker (*n.*) a shoot thrown out from the base of a tree or plant; specifically one arising from the root below ground level, frequently at some distance from the stem. Also, a side-shoot from an axillary bud, as in tomato plants or maize.

Sucker (*v.*) to produce suckers.

Suffrutex (*pl.* **suffrutices**) a plant woody at the base but herbaceous above; a subshrub.

Syconium (*pl.* **syconia**) A multiple fruit developed from numerous flowers embedded in a fleshy receptacle, such as the fruit of a fig. The swollen stem structure is the edible portion, as in *Ficus*.

Symbiosis an interaction between two dissimilar organisms living in close physical association; especially one in which each benefits the other.

Sympodial (of growth) pertaining to, of the nature of, or producing a sympodium.

Sympodium an apparent axis formed by successive lateral growth, each year's terminal bud dying at the end of the season. Compare monopodium.

T

Tap-root the primary, descending root.

Taxon (*pl.* **taxa**) a taxonomic group of any rank, as species, family, class, etc.; an organism contained in such a group.

Terrestrial growing on land or in the soil. Opposite aquatic, epiphytic.

Testa (*pl.* **testae**) the protective outer covering of a seed; the seed-coat.

Thorn a curved spine; sometimes a term applied to a sharply-pointed branch.

Transpiration the loss of moisture by evaporation from the surface of a plant, esp. from the stomata of the leaves.

Tuber (*n.*) a much thickened underground part of a stem or rhizome, for example in the potato, serving as a food reserve and bearing buds from which new plants arise. A thickened fleshy root, for example *Impatiens flanaganiae, Plectranthus esculentus*.

Turgidity swollen, distended condition.

U

Understorey a thing compared to a storey of a building; each of a series of stages or divisions lying horizontally one over the other; specifically, a layer within the canopy of a forest.

Unisexual of one sex; containing either stamens or pistil, but not both, the other sex being on the same plant (monoecious) or on a different plant (dioecious).

W

Weeping (of branches) having long drooping branches, as in Weeping Willow (*Salix*), or *Chamaecyparis funebris*.

Wilding a term used for wild germinated seedlings often found under the parent tree or plant.

Wilting temporary loss of turgidity in leaves, stem, etc., due to insufficient water in the tissues, or more permanently, to excessive watering causing an unhealthy condition in the roots. Also known as flagging. Compare permanent wilting point.

Wing a flattened outgrowth from a fruit or seed which assists in the wind-dispersal of the seed or fruit.

Woodland a vegetation type composed largely of trees, where the crowns of the trees are well-spaced apart or just touching, with only a herb layer beneath the canopy. Compare forest.

Some of the definitions used in this glossary are from my personal plant bible, *Macmillan's Tropical Planting and Gardening* (Barlow *et al.*, 1991).

Index

This index lists the scientific names of families and genera mentioned in the text, as well as the common names of families listed in Chapter 6, where these were available. Genus names are in *italics*, family names are in CAPITALS, and common names are in roman type. Index compiled by Marthina Mössmer.

C

D

P

Q

R

S

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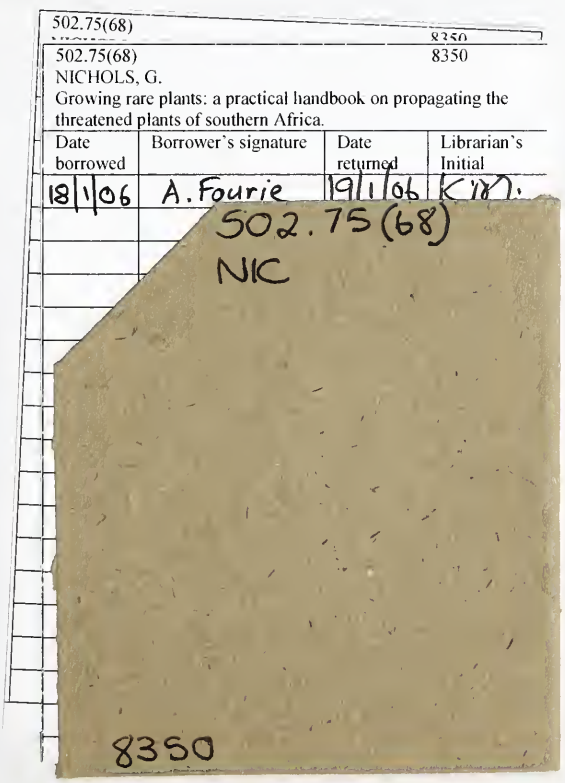

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This publication is a product of the Southern African Botanical Diversity Network (SABONET), a programme aimed at strengthening the level of botanical expertise, expanding and improving herbarium and botanic garden collections, and fostering closer collaborative links among botanists in the southern African subcontinent.

The main objective of SABONET is to develop a strong core of professional botanists, taxonomists, horticulturists, and plant diversity specialists within the ten countries of southern Africa (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe). This core group will be competent to inventory, monitor, evaluate, and conserve the botanical diversity of the region in the face of specific development challenges, and to respond to the technical and scientific needs of the Convention on Biological Diversity.

To enhance the human resource capacity and infrastructure available in the region, SABONET offers training courses, workshops, and collaborative expeditions in under-collected areas. The programme produces a newsletter, SABONET News, and a series of occasional publications, the Southern African Botanical Diversity Network Report Series, of which this publication is part.

SABONET is co-funded by:
- The United States Agency for International Development (USAID/World Conservation Union—Regional Office for southern Africa (IUCN-ROSA)
- The Global Environment Facility (GEF)/United Nations Development Programme (UNDP)

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